IRONDALE DBCP CONTROL SYSTEM

ROCKY MOUNTAIN ARSENAL

REVIEW OF 1986 OPERATIONS

BY

E. W. SWIFT
C. Y. CHIANG

SHELL OIL COMPANY

JULY 1987

BRHM8700104

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE
07/00/87

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
IRONDALE DBCP CONTROL SYSTEM, ROCKY MOUNTAIN ARSENAL, REVIEW OF 1986 OPERATIONS

5. FUNDING NUMBERS

6. AUTHOR(S)
SWIFT, E.; CHIANG, C.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
SHELL OIL COMPANY
DENVER, CO

8. PERFORMING ORGANIZATION REPORT NUMBER
87271R01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

THE PURPOSES OF THIS REPORT ARE TO 1) REVIEW CALENDAR YEAR 1986 OPERATIONS OF THE IRONDALE DBCP CONTROL SYSTEM AND 2) ASSESS ITS EFFECTIVENESS FOR REMOVING DBCP FROM THE ALLUVIAL AQUIFER. GROUND WATER LEVEL CONTOUR MAPS AND DBCP CONCENTRATION MAPS ARE PRESENTED FOR EACH QUARTER TOGETHER WITH AN INTERPRETATION OF THE DATA.

NO DBCP WAS DETECTED IN RESIDENTIAL WELLS WHICH WERE MONITORED IN THE IRONDALE COMMUNITY DURING 1986. NO DBCP WAS DETECTED IN THE SIX MONITORING WELLS ON THE RMA DOWNGRADIENT OF THE RECHARGE WELLS. BASED ON THESE AND OTHER ANALYSES, THE CONTAINMENT AND TREATMENT SYSTEM CONTINUES TO BE EFFECTIVE IN PREVENTING THE MIGRATION OF DBCP OFF THE ARSENAL.

14. SUBJECT TERMS
DEWATERING WELLS, CARBON HANDLING EQUIPMENT, CHEMICAL DATA

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
UNCLASSIFIED

18. SECURITY CLASSIFICATION OF THIS PAGE

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

87271R01
2nd Copy

Shell Oil Company

One Shell Plaza
P.O. Box 4320
Houston, Texas 77210

July 17, 1987

USATHAMA
Office of the Program Manager
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-PM: Col. Wallace N. Quintrell
Bldg. E4460
Aberdeen Proving Ground, MD 21010-5401

Dear Colonel Quintrell:

The enclosed report reviews the performance during calendar year 1986 of the Irondale DBCP Control System located on the Rocky Mountain Arsenal.

Sincerely yours,

C.K. Hahn

C. K. Hahn
Manager
Denver Site Project

RDL:ajg

Enclosure

cc: (w/enclosure)
USATHAMA
Office of the Program Manager
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE: Chief: Mr. Donald L. Campbell
Bldg E4585, Trailer
Aberdeen Proving Ground, MD 21010-5401

USATHAMA
Porgram Manager Staff Office
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-PM-R: Mr. David Heim
Commerce City, CO 80022-2180

BRHM8701705

cc: Mr. Robert L. Duprey
Director, Air & Waste Management Division
U.S. Environmental Protection Agency, Region VIII
One Denver Place
999 18th Street, Suite 1300
Denver, CO 80202-2413

Mr. Thomas P. Looby
Assistant Director
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220

Mr. Chris Sutton
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220

TABLE OF CONTENTS

SECTION		PAGE
EXECUTIVE SUMMARY		1
I.	BACKGROUND	2
II.	PURPOSE AND SCOPE	5
III.	DATA COLLECTION/ANALYSES	5
	A. System Operations	5
	B. Groundwater Elevations	14
	C. Chemical Data	16-18
IV.	CONCLUSIONS	18-19

PLATES		
PLATE 1	Map of RMA and Denver Vicinity	3
PLATE 2	Irondale DBCP Control System	4
PLATE 3	Recharge Distribution System - Piping Plan	6
PLATE 4	Dewatering Well Collection System - Piping Plan	7
PLATE 5	Carbon Handling Equipment	8
PLATE 6	Irondale Control System - Total Flow (gpm). Addendum: Operational Factors and Incidents Effecting Flow Rate	9-13
PLATE 7	Irondale DBCP Control System - Well Location Map	15

APPENDIX A:	GROUNDWATER ELEVATION DATA	A-1 THRU A-13
APPENDIX B:	CHEMICAL DATA	B-1 THRU B-12

EXECUTIVE SUMMARY

This report summarizes the operation of Irondale DBCP Control System ("the system") during the calendar year 1986. Groundwater level contour maps and DBCP concentration maps are presented for each quarter together with an interpretation of the data.

No DBCP (1,2-dibromo-3-chloropropane) was detected in residential wells which were monitored in the Irondale community during 1986. No DBCP was detected in the six monitoring wells on the RMA downgradient of the recharge wells.

The unconfined alluvial aquifer exhibited the approximate same seasonal flow fluctuations in 1986 as in prior years since the project began in December 1981. During the late spring and summer months, the South Adams County Water and Sanitation District (SACWSD) municipal well field exhibited a cone of depression which influenced the extreme western portion of the system. Again, as in previous years, the system was managed to effectively prevent the drawing of the DBCP plume away from the system, i.e., in the four winter months of low SACWSD pumping, extraction wells nearest the SACWSD well field were shut down and wells farthest from the well field pumped continuously to draw the narrow DBCP plume farther into the system's extraction well field. Near the end of high summer water pumping, the DBCP plume was drawn slightly to the west edge of the extraction system. By late fall, the extraction wells nearest the SACWSD well field were again below detection limit (0.06 ppb) of DBCP and were shut down on December 1, 1986, to repeat the cycle in 1987-88.

The system operated at a 97.5% stream factor for the year. Carbon change-out and electrical power failures represented about 85% of the system down-time. Total flow through the system ranged between 1025 gpm and 1570 gpm and averaged about 1325 gpm. The DBCP concentration in the feed to the granular activated carbon (GAC) treatment system ranged from $<$ 0.2 ppb to 0.47 ppb and averaged 0.32 ppb. Effluent samples from the GAC treatment system were below the DBCP detection limit for the entire year.

Based upon these analyses, the containment and treatment system continues to be effective in preventing the migration of DBCP off the RMA.

IRONDALE DBCP CONTROL SYSTEM--
REVIEW OF 1986 OPERATIONS

I. BACKGROUND

In March 1980 DBCP (1,2-dibromo-3-chloropropane) was discovered in some of the water wells producing from the alluvial aquifer in the Irondale community, located along the Northwest Boundary of RMA. A map of RMA and Denver vicinity is shown in Plate 1.

Chemical and groundwater level data developed subsequent to March 1980 from the limited number of monitoring wells which existed at that time indicated that DBCP-contaminated groundwater was moving off RMA at the northwest corner of Section 33. The data also indicated the contaminated groundwater extended northwest from the area of the rail classification yard in Section 3.

In order to eliminate the migration of contaminated groundwater, Shell Chemical Company constructed a control system, known as the Irondale DBCP Control System, in the northwest corner of Section 33. A plan view of the original system is shown in Plate 2. The system was designed to intercept the contaminated alluvial aquifer, remove the contaminant from the water, and inject the treated water back into the alluvial aquifer.

The original system was composed of the following:

° Two rows of dewatering wells - 15 wells in Row 1 (front or updip row) and 18 wells in Row 2 (rear row).

° A common feed sump - 40M gallon capacity.

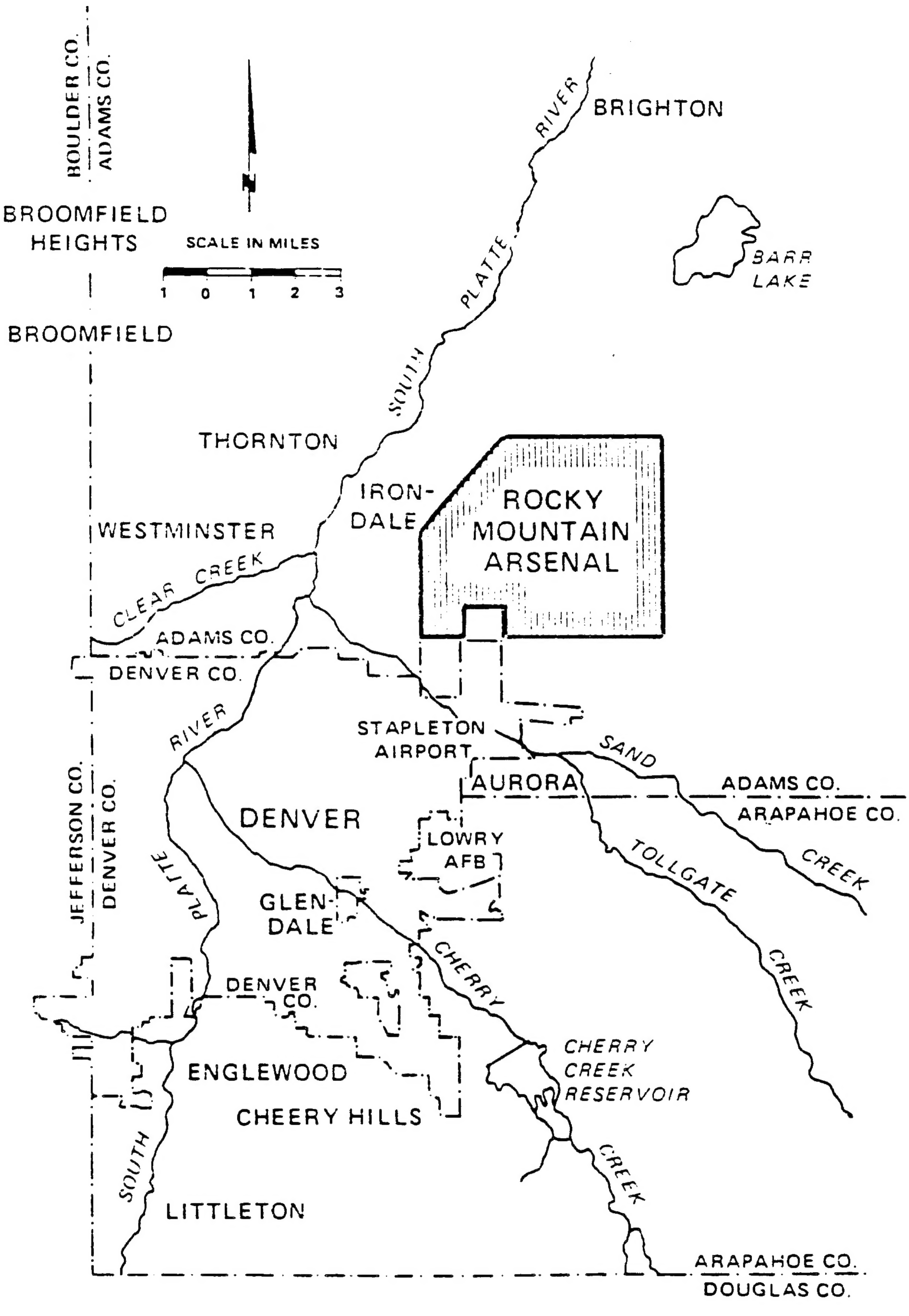
° Two up flow, pulse bed, granular activated carbon (40M lbs each) adsorbers operating in parallel.

° Two 700 GPM feed pumps.

° Three pre- and three post fiber cartridge element type filter units to service each adsorber.

° Fourteen recharge wells designed to handle 100 plus GPM each.

° Five monitoring wells downstream of the recharge wells, together with several other monitoring wells located in various areas within the treatment facility.



MAP OF RMA
DENVER VICINITY

PLATE 1

IRONDALE DBCP CONTROL SYSTEM

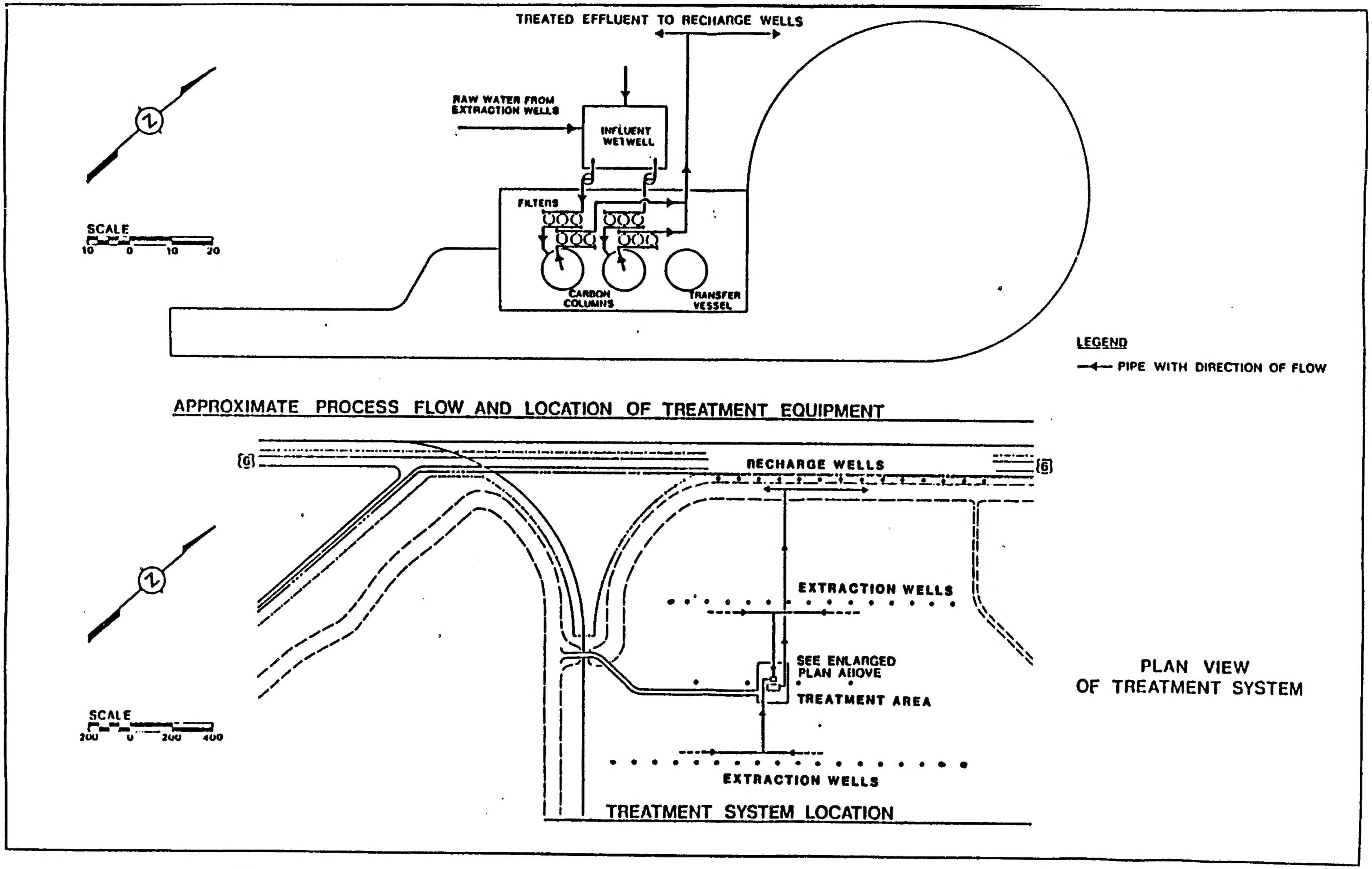


PLATE 2

The system was placed in operation in December, 1981 and ran effectively, reducing contamination of well water in Irondale to below detection level of 0.06 ppb by October, 1983.

In the late winter of 1983, difficulty was experienced with recharging treated water. Consequently, the fourteen recharge wells were cleaned in early January, 1984. Six additional recharge wells were installed in February, 1984 and two more in April. One new monitoring well on the southwest end of the monitoring well row was installed in April. The expanded recharge system is shown in Plate 3.

The dewatering well system was expanded in May, 1984 by five wells (three wells on the southwest end of the second row and two on the southwest end of the first row) to a total of thirty-eight. The expanded extraction system is shown in Plate 4.

The metal seats of all twelve cartridge type (20 micron) case filters were reworked during First Quarter, 1984. Two banks of bag type (5 micron) guard filters were installed downstream of the cartridge filters in May, 1984. The sump level control system was modified in August, 1984 to provide improved feed control to the adsorbers. In addition, a 3,000 lb. virgin carbon modular defining system was installed in February, 1984. This system was coupled with a 40,000 lb. bulk virgin carbon storage tank in November, 1984. A sketch of this system is shown in Plate 5.

II. PURPOSE AND SCOPE

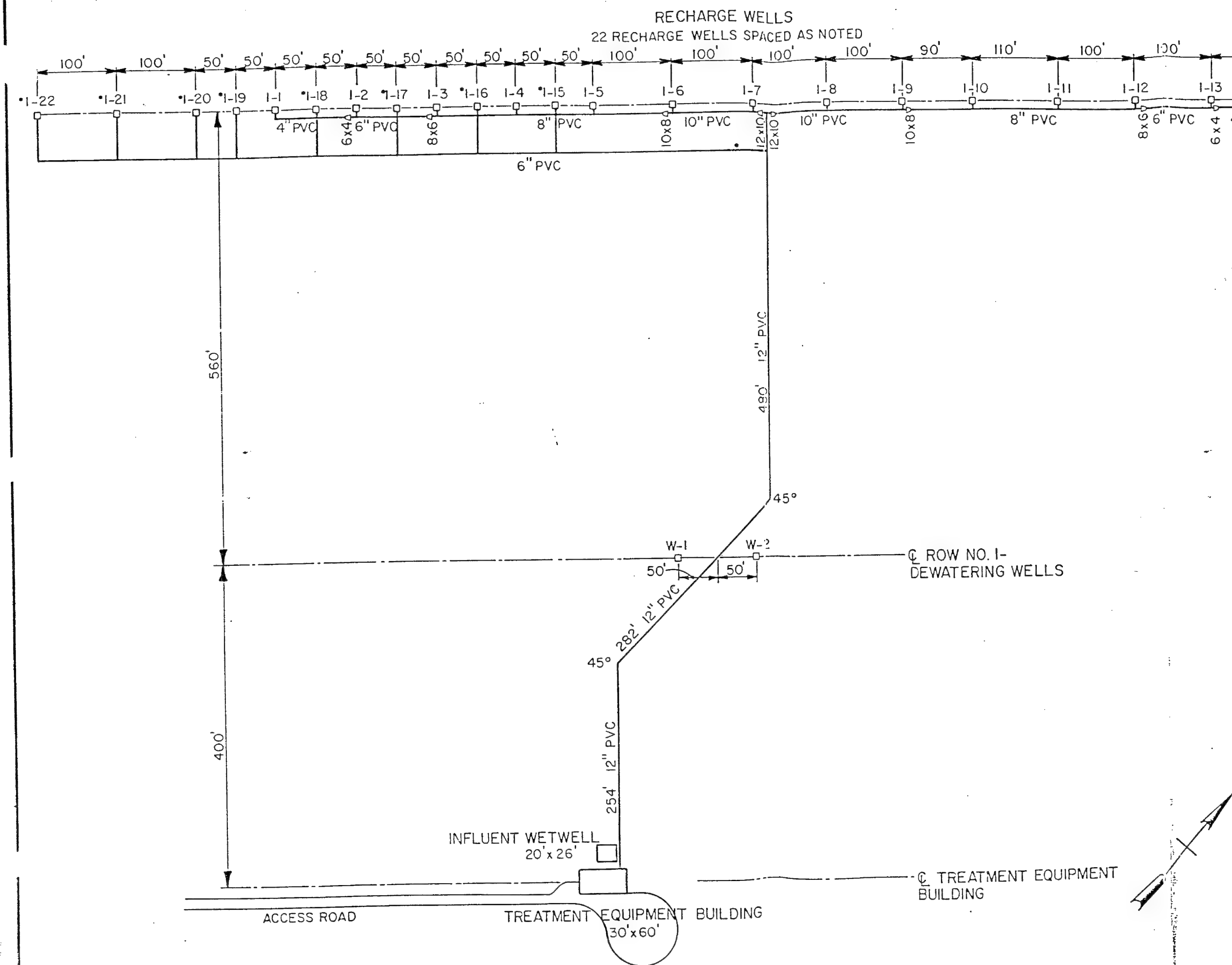
The purpose of this report is to review 1986 operations of the system and to assess its effectiveness for removing DBCP from the alluvial aquifer approaching the Irondale community. Reports presenting evaluations of the Irondale DBCP Control System for the periods of December, 1981 to September, 1984 were prepared by the U.S. Army Engineer Waterways Experimental Station (WES) in Vicksburg, Mississippi and issued in December, 1984 (RIC 84065R01 and 85130R01). A draft report for 1985 FY was prepared by WES. However, the final report has not been issued.

The geology and hydrology associated with the system and surrounding area were discussed in the December, 1984 Waterways Report and will not be repeated here.

III. DATA COLLECTION/ANALYSES

A. System Operations

Weekly average total flow rates through the two GAC adsorbers, which were operated in parallel, are presented in Plate 6. Operational factors and incidents which effected the quantity of flow through the system are presented as an attachment to Plate 7. Total flow ranged from 1025 gpm to 1570 gpm and averaged 1325 gpm



GENERAL NOTES

1. ALL PIPE IS SCHEDULE 40 PVC UNLESS OTHERWISE NOTED
2. ALL PIPE MINIMUM 3' BURY

REFERENCE:
RUBEL AND HAGER, INC.
CONSULTING ENGINEERS,
TUSCON, ARIZONA
DRAWING NO. AA-1-021
REV. 1, 7-23-81
• ADDENDUM

SHELL CHEMICAL COMPANY
A DIVISION OF SHELL OIL COMPANY
DENVER

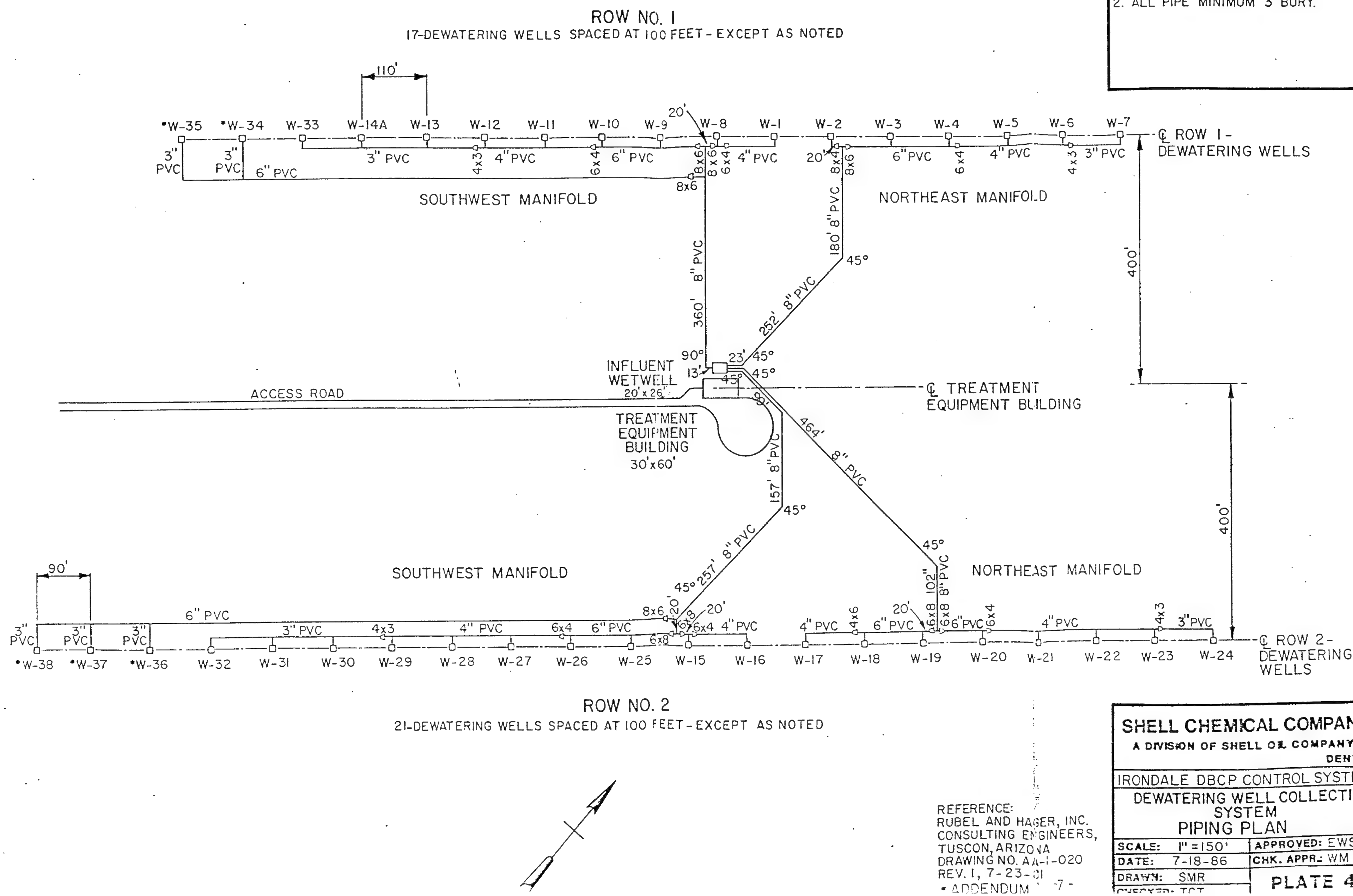
IRONDALE DBCP CONTROL SYSTEM
RECHARGE DISTRIBUTION SYSTEM
PIPING PLAN

SCALE: 1" = 120'		APPROVED: EWS
DATE: 7-18-86		CHK. APPR.: WM
DRAWN: SMR		PLATE 3

-6-

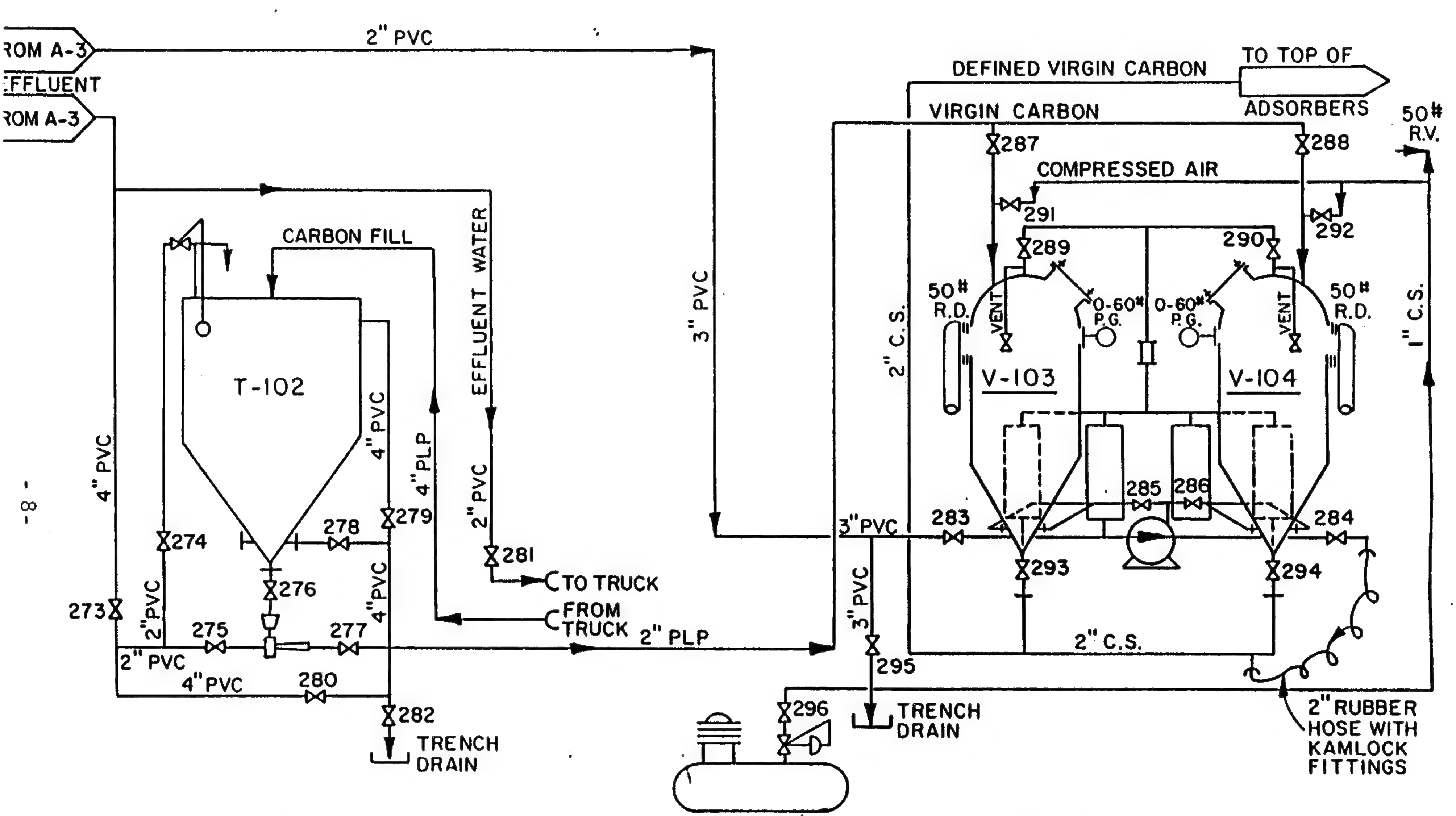
GENERAL NOTES

1. ALL PIPE IS SCHEDULE 40 PVC UNLESS OTHERWISE NOTED.
2. ALL PIPE MINIMUM 3' BURY.



REFERENCE:
RUBEL AND HAGER, INC.
CONSULTING ENGINEERS,
TUSCON, ARIZONA
DRAWING NO. AA-1-020
REV. 1, 7-23-81
• ADDENDUM

SHELL CHEMICAL COMPANY	
A DIVISION OF SHELL OIL COMPANY DENVER	
IRONDALE DBCP CONTROL SYSTEM	
DEWATERING WELL COLLECTION SYSTEM PIPING PLAN	
SCALE: 1" = 150'	APPROVED: EWS
DATE: 7-18-86	CHK. APPR.: WM
DRAWN: SMR	PLATE 4
CHECKED: TCT	



T-102
VIRGIN CARBON STORAGE TANK

VERTICAL CYLINDRICAL OPEN TOP VESSEL WITH CONICAL 104" HOPPER BOTTOM, 10'-0" DIA. x 8'-0" STRAIGHT SIDED. CAPACITY 21M LBS. CARBON DRY WEIGHT. LINING-PLASITE 4020-40 MIL DFT

AIR COMPRESSOR

QUINCY MODEL NO. 340-35
2 CYL., 7.5HP MOTOR
240/480V. 3PHASE. 200 LBS.
MAX. WORKING PRESSURE.
80 GAL. TANK CAPACITY.

V-103 V-104
VIRGIN CARBON DEFINE MODULE

2-65 CU. FT. VESSELS RATED AT 50PSI MAX. WORKING PRESSURE. 40.5" CONICAL HOPPER BOTTOM, 46" I.D. x 48.37" STRAIGHT SIDED CARBON STEEL RUBBER LINED. 4 CARBON STEEL SINGLE BAG FILTER CASES. GOULDS PUMP-10HP 3500 RPM MOTOR

CARBON HANDLING EQUIPMENT

NO SCALE

PLATE 5

PLATE 5

IRONDALE CONTROL SYSTEM
1986 TOTAL FLOW (G.P.M.)

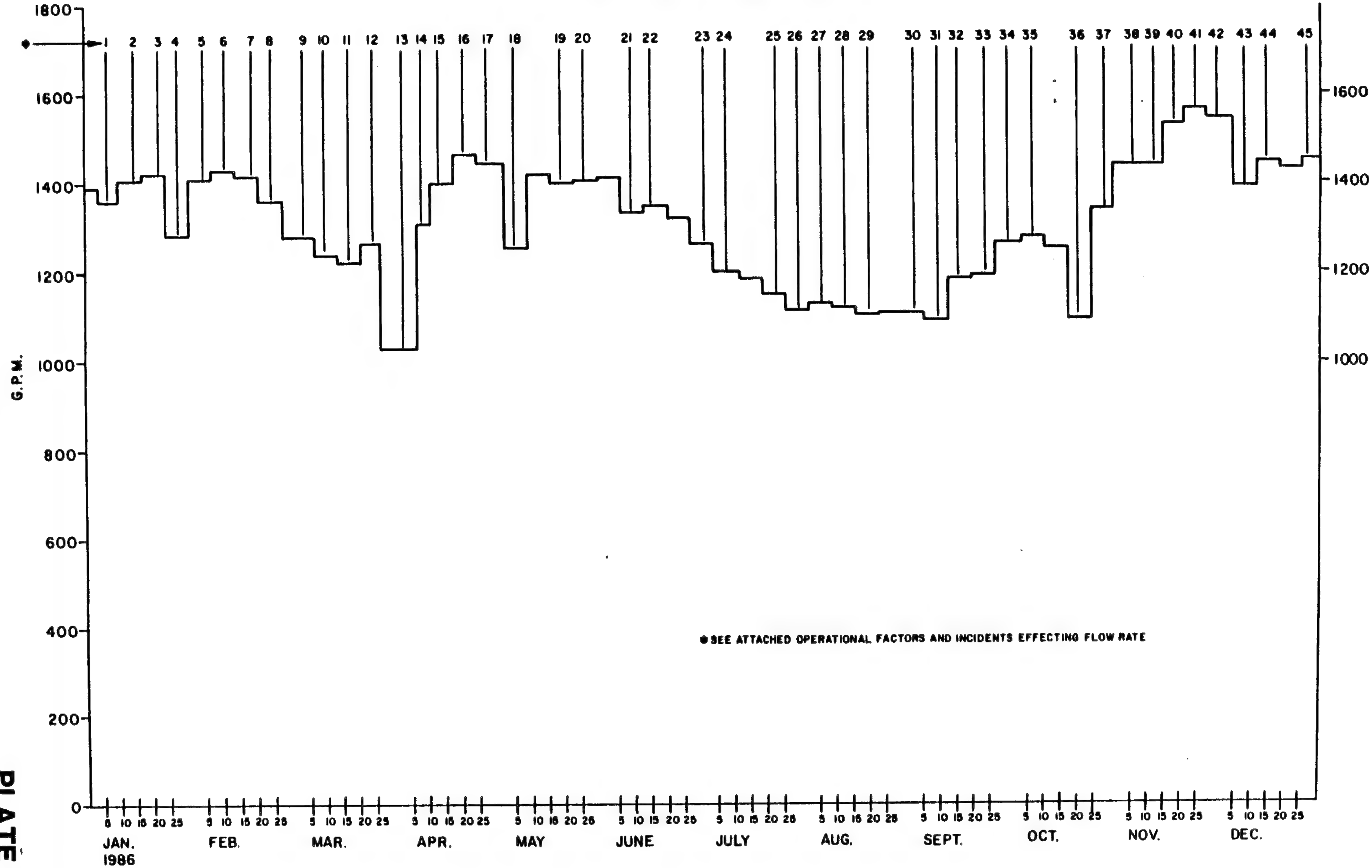


PLATE 6

OPERATIONAL FACTORS AND INCIDENTS EFFECTING FLOW RATE

1. V-101 down 6.7 hrs. 1/7/86 to add carbon. Added total of 5,400 lbs. due to slipped septa problem. Row 2 off 10 min., Row 1 off 10.5 hrs., W-7 off 22.5 hrs.

2. V-102 down 1.5 hrs. 1/16/86 to add 2,950 lbs. of carbon. Row 1 off 2.0 hrs.

3. Changed out W-32 pump and motor 1/22/86. Replaced horizontal check valve on W-36, 1/22/86. Row 1 off 10 minutes 1/22/86 due to plugged filter during defining.

4. V-102 down 3 hrs. 1/28/86 to add 2,700 lbs. of carbon. V-102 sump pump failed at 1000, 1/29/86. Overload apparently tripped V-101 sump pump too. V-101 pump back online 1700, 1/29. V-102 sump pump replaced and back in service 1430 1/30/86. W-7 off since 1/29 to accommodate adsorbers. Row 2 off 5.7 hrs. this week. Row 1 off 23 hrs. to 48 hrs. depending on load center to accommodate unit capacity.

5. Installed 3 hp Grundfos pump on W-21 2/3/86. Row 1 off 1-3/4 hrs. while unloading virgin carbon. W-7 turned on 0730 2/6/86.

6. V-101 down 1 hr. 2/11/86 to add 3,400 lbs. of carbon. Row 1 off 70 min. Installed new Grundfos Pump on W-19. W-19 off 65 hrs.

7. Installed new 7-1/2 hp pump on W-37 2/18/86. V-102 down 45 min. 2/20/86 to add 3,000 lbs. of carbon. Row 1 off of 57 min.

8. Unit down 4.25 hrs. 2/22/86 due to planned power outage by Army Row 2 off 4.25 hrs., Row 1 off 18.7 hrs., W-34, 35, 36, 37, 38 all turned off 1245 2/26/86.

9. V-101 down 1 hr. 55 min. 3/4/86 to add 3,200 lbs. of carbon. Row 1 off average of 127 min.

10. Unit down 5.7 hrs. 3/8/86 due to planned power outage by Army. Row 2 off 5.7 hrs., Row 1 off 5.7 hrs.

11. Unit down 8.7 hrs. 3/15/86 due to planned power outage by Army. Row 2 off 8.67 hrs., Row 1 off 8.82 hrs.

12. V-102 down 1 hr. 15 min. 3/26/86 to add 3,200 lbs. of carbon. Row 1 off 82 min.

13. Storm caused power outage and closed Arsenal 4/3 and 4/4. Restarted unit 4/5/86 at 0818. Unit down 51.9 hrs., Row 2 off 51.87 hrs., Row 1 off 55.8 hrs.

14. V-102 down 2.27 hrs. to clear pressure across bed and clean and repair septa, 4/9/86. Row 2 off 14 min., Row 1 off 4.82 hrs.

15. Turned on Extraction Wells #W-34 thru W-38 4/15/86.

16. Installed new 3 hp Grundfos pump and motor in W-23 4/22. Replaced 7-1/2 hp pump and motor in W-22 with 3 hp Grundfos 4/22, down 2 hrs. W-18 off 2 hrs. for repair. Down 2.2 hrs. 4/23 to add 3,200 lbs. of carbon to V-101. Row 1 off average of 2.7 hrs. W-7 of 4.6 hrs.

17. Down 4/30 for 1.5 hrs. to add 2,600 lbs. of carbon to V-102. Row 1 off 2.6 hrs. total due to other problems.

18. Unit down due to power failure 1320 - 5/4 to 1130 - 5/5. Row 1 off average of 23.74 hrs., Row 2 off 22.2 hrs.

19. W-9 off 1.9 hrs. 5/22 to change out pump and motor.

20. V-101 down 50 min. 5/27 to add 3,200 lbs. of carbon. V-102 down 73 min. 5/29 to add 3,200 lbs. of carbon. Row 1 off average of 2.4 hrs.

21. W-6 quit running 2330 6/7.

22. W-6 started at 1455 6/13 Sky Country found contact loose. Unit down due to power failure caused by rain and lightning storm 6/16/86 1900-2100. Row 2 off 1.95 hrs., Row 1 off 2.11 hrs.

23. Included 6 days, rather than the normal 7, (6/27 to 7/3) due to holiday, Friday 7/4/86.

24. V-101 down 6.8 hrs. 7/7 to add 3,200 lbs. of carbon. V-102 down 1.2 hrs. 7/10 to add 3,200 lbs. of carbon. Row 1 off 5.65 hrs.

25. W-15 off 2-3 hrs. possible weather caused.

26. V-101 down 77 min. 7/31 to add 3,100 lbs. of carbon. W-35 quit pumping ~1530 7/24, broken pump shaft. Replaced on Wednesday 7/30. Also W-8 pump quit 1700 7/26. Replaced 1330 7/30.

27. V-101 down 100 min. 8/7 to add extra pulse of carbon 2000 lbs. to upgrade carbon bed. Found W-2 off 1600 8/5. Restarted 8/6 ~0900. Row 1 off 91 min. during carbon pulse.

28. Lightning strike burned thru cable and caused power outage 8/8, power off 15 hrs.

29. V-102 down 163 min. 8/18 to add 2,800 lbs. of carbon. Row 1 off 2.3 hrs.

30. Replaced broken Omnitrol level controller in W-35 & W-33, 9/3.

31. Power failure at 1145, 9/10; bird flew into transformer. Following repairs unit back-up at 1500, 9/11. V-101 down 70 min. on 9/12 to add 3,200 lbs. of carbon. Row 2 off 3.7 hrs., Row 1 off 25 hrs.

32. Row 1 off 1.1 hrs. to install cellular telephone 9/15.

33. V-102 down 63 min. 9/25 to add 3,150 lbs. of carbon. Had to reset W-24 9/24 A.M.

34. Installed smaller valves in W-37 (1 inch) and W-2 (2 inches) 9/26 to control flows better. Load centers 2 & 3 in Row 2 off 71 min., 4, 5, 6 load centers Row 1 off 40 min.. W-37 breaker tripped 9/29 A.M. Found W-2 breaker tripped 10/3 A.M.

35. Unit down 155 min. 10/5/86 due to power failure caused by bird. Row 2 off average of 155 min.; Row 1 off 168 min.

36. Unit down 24 min. 10/21 to complete elect. hookup of auto. dialer in Bldg. 809. V-101 down 29.2 hrs. 10/22 and 10/23 to add 10,600 lbs. carbon. Row 2 off 29 min. 10/21, Row 1 off 21.8 hrs. W-7 off until 0745 10/24 to accommodate unit capacity on starting after carbon change.

37. Added 3,600 lbs. of carbon to V-102, 10/29. Unit down at 2020, 10/30 due to power failure. Row 2 down 11.6 hrs., Row 1 off total of 17.1 hrs., W-7 off 34 hrs. to accommodate unit capacity.

38. Reset breaker on W-24, 11/3 A.M. Reset breaker on W-1, 11/5 A.M.

39. Found W-15 and W-28 off 0730, 11/10. Reset W-15, run OK. Replaced omnitrol on W-28. Found W-19 off 0730, 11/14. Replaced motor. Row 1 off 63 min. while transferring spent carbon for shipment.

40. Changed out W-19 3 hp pump 11/14/86.

41. Replaced pumps on W-15 (7-1/2 hp) and W-2 (7-1/2 hp) on 11/21.

42. Shut pumps off on wells W-34, 35, 37, 38, at 12:30 PM 12/1/86.

OPERATIONAL FACTORS AND INCIDENTS EFFECTING FLOW RATE

43. V-102 down 2-3/4 on 12/11, to add 3,200 lbs. of carbon. Row 1 down for 3 hrs.

44. V-102 down for approximately 1 hr. 10 min. to back flush, Row 1 off for approximately same period.

45. V-101 down for approximately 55 min. to back flush, Row 1 off for approximately same period.

for the year. The low flow, which occurred over an eleven day period commencing March 28, was due to a power outage resulting from a severe snow storm.

The system operated at an overall stream factor of 97.5 percent for the year. Power failures represented about 64% of the down time while carbon change-out and maintenance were 20% and 16%, respectively.

Semimonthly influent and effluent DBCP concentrations for the carbon adsorption system are shown in Table 1 of Appendix B. The DBCP level in the feed ranged from below the limit of determinability (0.2 ppb) to 0.47 ppb and averaged 0.32 ppb. The effluent was below the detection limit of 0.06 ppb DBCP for the entire year.

B. Groundwater Elevations

Prior to January, 1986, a cooperative monitoring program between RMA personnel and Shell was conducted to evaluate the effectiveness of the system. Commencing in 1986, Shell assumed full responsibility for both chemical sampling and water level measurements. The monitoring program was continued quarterly with samples and groundwater elevation measurements taken in January, April, July, and October.

Groundwater elevation measurements taken each quarter of 1986 are presented in Table 2 of Appendix A. The data are arranged by section (first two digits are the section and the last three identify the well number). Plate 7, shows the general location of wells that are included in the monitoring program.

Machine-drawn groundwater level contours based solely on the data presented on Table 2 do not fully depict the flow patterns due to lack of data in some of the neighboring sections. Consequently, to produce groundwater elevation contours representing the regional flow pattern, measurements made by the Army of some specific wells in Sections 2, 27, and 35 were incorporated with the data in Table 2. Measurements made by the Army in October, 1985 (Table 2A of Appendix A) were added to the regular data for January, 1986 to produce the contour map shown in Figure 1 of Appendix A. Measurements made by the Army in August, 1986 (Table 2B of the Appendix) were added to the April, July, and October data shown in Table 2 to produce contour maps for these respective quarters shown in Figures 2, 3, and 4. Each of these four figures exhibits the same general flow pattern. The direction of the regional groundwater flow is northwesterly toward the system. Further, the flows near the system converge toward the two extraction rows. An

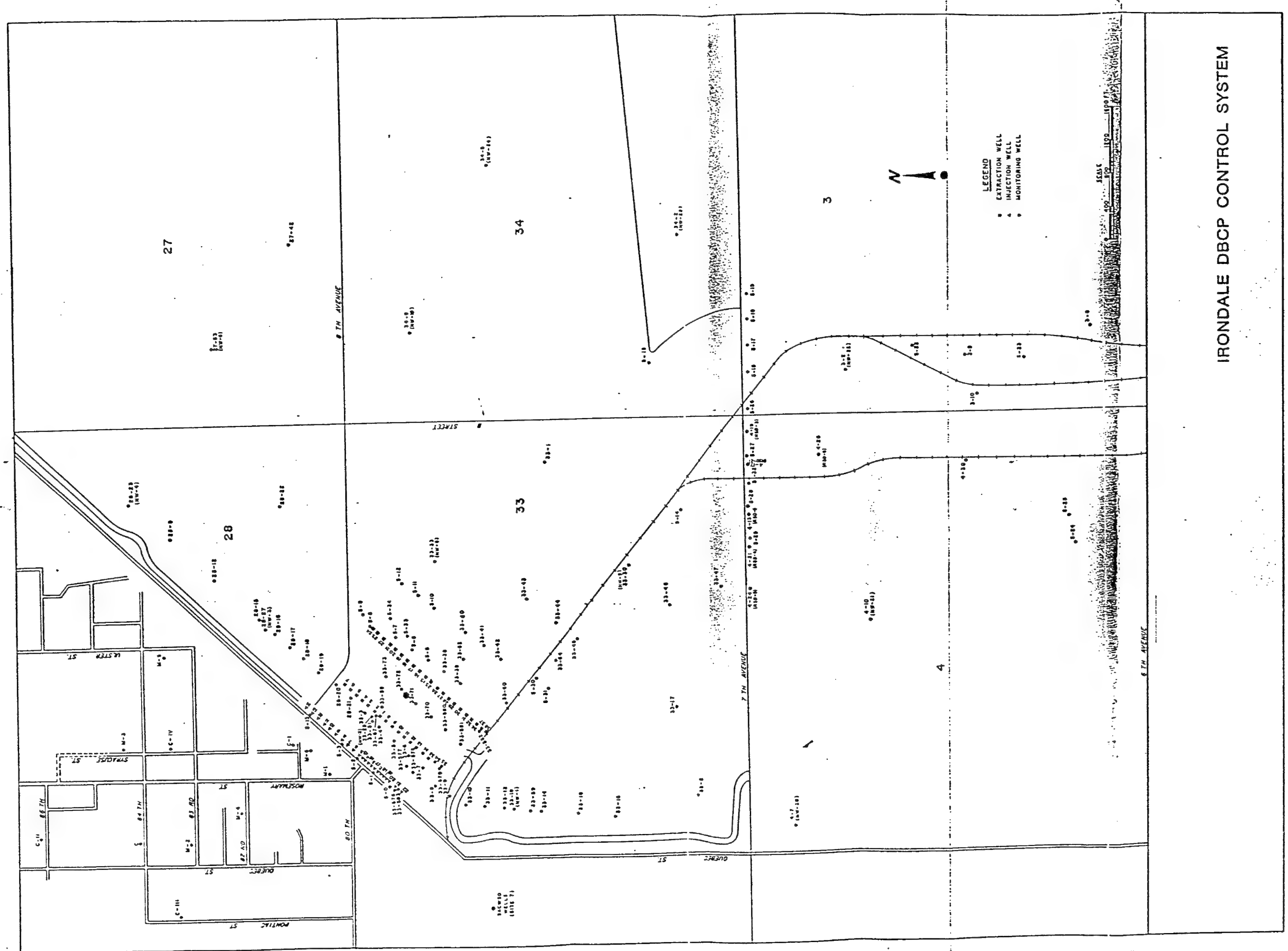

IRONDALE DBCP CONTROL SYSTEM
LEGEND
EXTRACTION WELL
INJECTION WELL
MONITORING WELL
SCALE
N
3
4
27
28
33
34
6 TH AVENUE
7 TH AVENUE
8 TH AVENUE
STREET
QUEBEC ST
PONTIAC ST
ROSEMARY ST
ULSTER ST
SYRACUSE ST
80 TH
82 ND
83 RD
84 TH
86 TH

PLATE 7

enlarged groundwater level map based on October, 1986 data (Figure 5, Appendix A) clearly shows the effective flow direction toward the two rows of extraction wells.

The 1986 flow patterns and groundwater elevations exhibited approximately the same seasonal fluctuation as in previous years. During the late spring and summer months, the SACWSD municipal well field exhibited a cone of depression which influenced the extreme western portion of the system. This is demonstrated by the groundwater elevation data listed in Table 3, Appendix A for the April and October, 1986 sampling periods. The data show a range of groundwater level decrease from April to October of between 0.08 ft. to greater than 12 ft. (Well 33012). Wells 33008, 33009, 33010, and 33011 exhibit groundwater elevation decreases of more than 2 ft. Table 4 lists the measured groundwater elevations of July, 1986 and October, 1986 and their differences. With a few exceptions, groundwater elevations in most of the wells decreased with time.

To estimate the average groundwater flow velocity, a transect hydrograph in the direction of flow has been produced. Based on Figure 6, an average hydraulic gradient is calculated to be 0.0035. Assuming a typical hydraulic conductivity of 10^{-3} for a sandy formation and an average porosity of 0.3, the average groundwater flow velocity is calculated to be 3.3 ft/day.

C. Chemical Data

The 1986 sample schedule together with the range and average DBCP concentration in each of the sampled wells are presented in Table 5 of Appendix B. The individual analyses of the wells for each quarter are shown in Table 6. Figure 7 shows the approximate location of all wells included in the sampling program and is the base map for the quarterly concentration contour maps.

The DBCP concentration data obtained during the four sampling periods were used to prepare concentration contour maps (Figures 8, 10, 11 and 12). Each map is discussed in detail below.

<u>January 1986 Sampling Period</u>

The DBCP concentration isopleths for January, 1986 are shown in Figure 8 of Appendix B. The highest concentration of 25.5 ppb was found in the sample collected from Well S-23, located at the rail classification yard. The DBCP concentration level decreased in the direction of the flow path toward the Irondale DBCP Control System. The flow path between Well S-23 and the system is relatively narrow and principally follows the well defined bedrock alluvium channel (Figure 9 of Appendix B).

No concentration at or above the detection limit (0.06 ppb) was found in either the system monitoring wells immediately downdip of the row of injection wells or in monitored wells in the Irondale community. DBCP was detected in concentrations below the lowest reportable level (0.2 ppb) in two wells in the downdip row of extraction wells. Measurable levels of DBCP were found in two monitoring wells located between the two rows of extraction wells: 0.65 ppb in well 33-70 and 0.24 ppb in well 33-580. A concentration of 2.1 ppb in updip extraction well W-25 was the highest concentration measured in the extraction well system.

April 1986 Sampling Period

Figure 10 shows the concentration isopleths for April, 1986. The general concentration distribution of the April sampling is similar to the January sampling. The effects of shifting extraction volumes to the northeast end during the winter months may be seen to effect the shape of the plume at the updip row of extraction wells.

No DBCP was detected in system monitoring wells immediately downdip of the row of injection wells or in monitored Irondale wells. DBCP was detected in only one well of the downdip extraction row: 0.28 ppb in W-2. DBCP was detected at levels below the limit of determinability (0.2 ppb) in two of the monitoring wells located between the two rows of extraction wells. The highest concentration found in the extraction well system was 1.7 ppb in updip extraction well W-16.

July 1986 Sampling Period

As in the two prior quarterly samplings, no DBCP was detected in either the system monitoring wells immediately downdip of the injection wells or in monitored Irondale wells. The concentration isopleths for July, 1986, Figure 11, display a slight drift of the DBCP plume to the southwest at the updip extraction row, probably due to the influence of the SACWSD wells. DBCP was detected in the most southwesterly well, W-38, in the updip extraction row but at a level below the limit of determinability (0.2 ppb). DBCP was detected in only one of the downdip extraction wells, W-2, at a level below the limit of determinability. Of the monitoring wells located between the extraction rows, only 33-70 registered positive for DBCP at 0.42 ppb. The highest concentration in the updip extraction well row as 2.49 ppb in W-25 which is located in approximately the middle of the row.

Upward-trending DBCP concentrations in well 33-30 located in the plume immediately updip of the extraction system presage arrival of increasing concentrations at the extraction system.

October 1986 Sampling Period

The concentration isopleths for October, 1986 are presented in Figure 12. By comparing the four sets of isopleths, a general increase in DBCP concentration within the extraction system is apparent. Upward and downward trending of plume DBCP concentrations is believed to reflect varying patterns and magnitudes of precipitation events in the general area that influences the alluvial aquifer. DBCP was detected in three wells in the downdip extraction row, two of which were below the limit of determinability. DBCP was present in three of the monitoring wells located between the two extraction rows. The highest concentration in the updip extraction wells was 3.29 ppb in W-31. W-38, the most southwesterly well in the updip extraction row, returned to BDL.

Again, no DBCP was detected in either the system monitoring wells immediately downdip of the injection wells or in monitored Irondale wells.

The 4.64 ppb DBCP level in 33-30 indicates a possible continuing up-trend in the DBCP concentration approaching the extraction system. As DBCP concentration in the GAC treatment plant influent increases, the frequency at which carbon is added to the adsorbers is adjusted. Due to DBCP's favorable adsorption isotherm, the frequency of carbon pulsing changes very little with increasing DBCP influent concentration. The frequency at which carbon is added to the adsorber can be adjusted according to the observed DBCP levels at the middle port in the adsorbers. The recharge wells, downgradient of the last row of extraction wells, provide a mound of water which partially recycles, thus reducing the potential for DBCP to escape the extraction system. However, if relatively high levels of DBCP continue to be observed in the last row of extraction wells, installation of additional extraction wells upgradient should be considered.

CONCLUSIONS

1. The unconfined alluvial aquifer exhibited the approximate same seasonal fluctuations in 1986 as in previous years.

2. No DBCP was detected in monitored wells of the community of Irondale during 1986, nor was DBCP detected in the row of system monitoring wells immediately downgradient of the injection wells.

3. The strategy of shutting down southwest extraction wells in the winter and pulling the DBCP plume away from the influence of SACWSD wells was again effective in preventing loss of DBCP from the plume to the municipal wells.

4. Carbon change-out and electrical problems were the major causes of downtime.

5. The updip concentration of DBCP in well 33-30 on October 14, 1986 of 4.64 ppb indicates a possible surge of higher than normal concentration approaching the system. Special attention will be given to the concentration of the surge upon arrival at the extraction system.

6. Continued close monitoring of the capacity of the injection wells will be maintained to insure adequate disposal of treatment volume.

7. The DBCP concentration maps and groundwater maps prepared on 1986 data indicate the control system is effectively intercepting and removing DBCP contaminated groundwater flowing toward the community of Irondale on the RMA.

APPENDIX A
GROUNDWATER ELEVATION DATA

	Page
Table 2 - 1986 Groundwater Measurement Data	A-1
Table 2A - October, 1985 Groundwater Measurement Data	A-4
Table 2B - August, 1986 Groundwater Measurement Data	A-5
Table 3 - Irondale Water Table Elevations for 4/86 and 10/86	A-6
Table 4 - Irondale Water Table Elevations for 7/86 and 10/86	A-7
Figure 1 - Irondale Water Level Contours 1/86	A-8
Figure 2 - Irondale Water Level Contours 4/86	A-9
Figure 3 - Irondale Water Level Contours 7/86	A-10
Figure 4 - Irondale Water Level Contours 10/86	A-11
Figure 5 - Blown-Up Water Level Contours Around Treatment System	A-12
Figure 6 - Irondale Transect Hydrograph	A-13

TABLE 2

1986 GROUNDWATER MEASUREMENT DATA

(Elevation, ft (msl) (add 5,100.00 to each reading)

Well No.	Jan 86	April 86	July 86	Oct 86
ARMY				
03001	35.69	35.62	36.30	35.38
03002	28.83	29.78	31.61	29.70
03008	58.41	58.21	60.01	58.07
03009	35.49	35.53	37.58	35.34
03010	36.38	36.30	37.66	36.18
SHELL				
03516	25.82	25.77	28.19	25.42
03517	25.89	25.94	28.63	25.56
03518	26.17	26.17	28.43	25.90
03519	26.44	26.42	28.73	26.11
03522	33.01	32.86	35.85	32.72
03523	41.55	41.58	44.19	41.45
03526	25.05	25.14	26.58	24.78
ARMY				
04010	28.19	28.15	29.17	27.42
04013	23.31	23.46	25.10	23.17
04017	24.59	24.59	25.46	24.11
04019	25.02	24.98	26.59	24.61
04021	22.94	22.99	24.03	22.34
04024	22.32	22.34	23.75	21.67
04026	27.35	27.43	28.70	27.10
04030	34.49	34.44	36.72	34.22
SHELL				
04524	39.58	39.50	42.02	39.21
04525	39.99	39.99	38.90	39.74
04527	24.54	24.63	25.83	24.19
04528	23.47	23.60	24.66	23.06
04529	22.89	23.00	24.18	22.42
04532	25.10	25.43	26.36	25.18
ARMY				
28016	01.40	01.30	-	00.73
28017	01.54	01.47	-	00.72
28018	01.88	01.84	04.67	00.97
28019	02.06	02.02	-	01.06
28020	02.26	02.15	04.75	01.19
28021	01.63	01.80	04.11	00.70
28022	08.89	08.83	06.28	08.62
28027	01.22	01.12	01.69	00.60

TABLE 2

1986 GROUNDWATER MEASUREMENT DATA

(Elevation, ft (msl) (add 5,100.00 to each reading)

Well No.	Jan 86	April 86	July 86	Oct 86
SHELL				
28503	08.08	08.15	05.89	06.79
28513	05.10	05.43	04.77	04.05
ARMY				
33001	15.63	15.55	15.86	15.26
33003	01.96	01.60	-	00.77
33004	01.40	01.19	-	99.92
33005	03.68	03.13	-	01.76
33006	04.60	04.06	-	02.56
33007	06.11	05.36	-	03.50
33008	05.80	05.38	-	03.19
33009	05.16	05.00	-	02.48
33010	05.49	05.12	-	02.93
33011	05.81	05.44	-	03.40
33012	04.49	13.85	-	01.66
33014	06.23	05.75	00.87	03.92
33017	18.48	18.10	18.43	-
33018	-	05.39	98.82	03.47
33025	02.15	01.67	02.05	00.86
33030	17.00	17.35	17.86	16.52
33033	10.04	10.02	11.04	09.71
33038	04.54	04.13	06.07	03.86
33039	06.07	06.44	05.16	05.53
33040	07.30	07.72	08.52	06.72
33041	08.33	08.73	08.83	07.64
33042	09.66	10.12	09.32	08.83
33043	12.13	12.61	13.57	11.44
33044	13.04	13.52	12.97	12.21
33045	-	14.21	12.88	12.90
33046	-	17.93	18.65	16.93
33047	21.37	21.31	22.58	20.56
33051	-	-	-	-
33059	-	05.92	99.54	03.98
33060	-	09.32	06.29	07.70
33062	06.86	07.22	-	-
33064	-	12.73	11.19	11.27

TABLE 2

1986 GROUNDWATER MEASUREMENT DATA

(Elevation, ft (msl) (add 5,100.00 to each reading)

Well No.	Jan 86	April 86	July 86	Oct 86
SHELL				
33500	09.97	09.83	06.59	07.69
33501	18.91	18.83	15.92	16.52
33502	13.05	13.07	13.73	11.38
33505	03.31	04.10	04.76	03.35
33506	03.08	03.33	04.45	02.71
33507	02.44	02.71	03.54	02.02
33509	03.74	03.80	05.23	03.13
33510	07.35	07.62	07.85	06.94
33511	07.61	07.61	09.07	07.11
33512	07.87	07.83	08.85	07.56
33514	20.63	20.80	21.83	20.24
33531	11.93	11.89	12.42	10.24
33533	02.50	02.71	04.12	02.06
33534	03.07	03.07	05.93	02.38
33570	03.06	03.71	07.42	02.62
33571	02.10	02.64	02.86	01.50
33572	01.02	01.45	02.80	00.62
33573	01.27	01.39	02.90	00.56
33576	-	14.85	08.10	10.93
33577	-	07.23	06.07	05.32
33578	-	06.51	-	04.62
33579	-	04.56	02.88	02.90
33580	03.47	04.05	04.27	02.78
33581	04.78	05.46	-	03.82
33582	04.44	04.90	02.54	03.02
Army				
34002	22.19	22.09	24.37	21.92
34008	10.93	10.81	11.79	10.72
SHELL				
34515	20.82	20.86	22.87	20.53

TABLE 2A

OCTOBER, 1985 GROUNDWATER MEASUREMENT DATA

Section	Well ID	Water Level (feet above MSL)
2	008	5195.37
	011	5207.61
	014	5196.82
27	007	5195.24
	040	5121.33
	041	5114.20
	042	5106.83
	043	5104.17
	044	5100.52
	051	5129.62
	053	5103.00
	072	5096.39
35	037	5170.17
	042	5173.16
	058	5185.73

TABLE 2B

AUGUST, 1986 GROUNDWATER MEASUREMENT DATA

Section	Well ID	Water Level (feet above MSL)
2	008	5195.96
	011	5207.02
	014	5196.43
27	007	5095.31
	040	5121.29
	041	5114.60
	042	5106.80
	043	5104.11
	044	5100.39
	051	5130.57
	053	5102.50

TABLE 3. IRONDALE WATER TABLE ELEVATIONS FOR 4/86 - 10/86

WELL	ELEV WATER 4/86	ELEV WATER 10/86	DELTA 4/86 10/86	WELL	ELEV WATER 4/86	ELEV WATER 10/86	DELTA 4/86 10/86
03001	5135.62	5135.38	-0.24	33014	5105.75	5103.92	-1.83
03002	5129.78	5129.70	-0.08	33018	5105.39	5103.47	-1.92
03008	5158.21	5158.07	-0.14	33025	5101.67	5100.86	-0.81
03009	5135.53	5135.34	-0.19	33030	5117.35	5116.52	-0.83
03010	5136.30	5136.18	-0.12	33033	5110.02	5109.71	-0.31
03516	5125.77	5125.42	-0.35	33038	5104.13	5103.86	-0.27
03517	5125.94	5125.56	-0.38	33039	5106.44	5105.53	-0.91
03518	5126.17	5125.90	-0.27	33040	5107.72	5106.72	-1.00
03519	5126.42	5126.11	-0.31	33041	5108.73	5107.64	-1.09
03522	5132.86	5132.72	-0.14	33042	5110.12	5108.83	-1.29
03523	5141.58	5141.45	-0.13	33043	5112.61	5111.44	-1.17
03526	5125.14	5124.78	-0.36	33044	5113.52	5112.21	-1.31
04010	5128.15	5127.42	-0.73	33045	5114.21	5112.90	-1.31
04013	5123.46	5123.17	-0.29	33046	5117.93	5116.93	-1.00
04017	5124.59	5124.11	-0.48	33047	5121.31	5120.56	-0.75
04019	5124.98	5124.61	-0.37	33059	5105.92	5103.98	-1.94
04021	5122.99	5122.34	-0.65	33060	5109.32	5107.70	-1.62
04024	5122.34	5121.67	-0.67	33064	5112.73	5111.27	-1.46
04026	5127.43	5127.10	-0.33	33500	5109.83	5107.69	-2.14
04030	5134.44	5134.22	-0.22	33501	5118.83	5116.52	-2.31
04524	5139.50	5139.21	-0.29	33502	5113.07	5111.38	-1.69
04525	5139.99	5139.74	-0.25	33505	5104.10	5103.35	-0.75
04527	5124.63	5124.19	-0.44	33506	5103.33	5102.71	-0.62
04528	5123.60	5123.06	-0.54	33507	5102.71	5102.02	-0.69
04529	5123.00	5122.42	-0.58	33509	5103.80	5103.13	-0.67
04532	5125.43	5125.18	-0.25	33510	5107.62	5106.94	-0.68
28016	5101.30	5100.73	-0.57	33511	5107.61	5107.11	-0.50
28017	5101.47	5100.72	-0.75	33512	5107.83	5107.56	-0.27
28018	5101.84	5100.97	-0.87	33514	5120.80	5120.24	-0.56
28019	5102.02	5101.06	-0.96	33531	5111.89	5110.24	-1.65
28020	5102.15	5101.19	-0.96	33533	5102.71	5102.06	-0.65
28021	5101.80	5100.70	-1.10	33534	5103.09	5102.38	-0.71
28022	5108.83	5108.62	-0.21	33570	5103.71	5102.62	-1.09
28027	5101.12	5100.60	-0.52	33571	5102.64	5101.50	-1.14
28503	5108.15	5106.79	-1.36	33572	5101.45	5100.62	-0.83
28513	5105.43	5104.05	-1.38	33573	5101.39	5100.56	-0.83
33001	5115.55	5115.26	-0.29	33576	5114.85	5110.93	-3.92
33003	5101.60	5100.77	-0.83	33577	5107.23	5105.32	-1.91
33004	5101.19	5099.92	-1.27	33578	5106.51	5104.62	-1.89
33005	5103.13	5101.76	-1.37	33579	5104.56	5102.90	-1.66
33006	5104.06	5102.56	-1.50	33580	5104.05	5102.78	-1.27
33007	5105.36	5103.50	-1.86	33581	5105.46	5103.82	-1.64
33008	5105.38	5103.19	-2.19	33582	5104.90	5103.02	-1.88
33009	5105.00	5102.48	-2.52	34002	5122.09	5121.92	-0.17
33010	5105.12	5102.93	-2.19	34008	5110.81	5110.72	-0.09
33011	5105.44	5103.40	-2.04	34515	5120.86	5120.53	-0.33
33012	5113.85	5101.66	-12.19				

TABLE 4. IRONDALE WATER TABLE ELEVATIONS FOR 7/86 - 10/86

WELL	ELEV WATER 7/86	ELEV WATER 10/86	DELTA 7/86 10/86	WELL	ELEV WATER 7/86	ELEV WATER 10/86	DELTA 7/86 10/86
03001	5136.30	5135.38	-0.92	33030	5117.86	5116.52	-1.34
03002	5131.61	5129.70	-1.91	33033	5111.04	5109.71	-1.33
03008	5160.01	5158.07	-1.94	33038	5106.07	5103.86	-2.21
03009	5137.58	5135.34	-2.24	33039	5105.16	5105.53	0.37
03010	5137.66	5136.18	-1.48	33040	5108.52	5106.72	-1.80
03516	5128.19	5125.42	-2.77	33041	5108.83	5107.64	-1.19
03517	5128.63	5125.56	-3.07	33042	5109.32	5108.83	-0.49
03518	5128.43	5125.90	-2.53	33043	5113.57	5111.44	-2.13
03519	5128.73	5126.11	-2.62	33044	5112.97	5112.21	-0.76
03522	5135.85	5132.72	-3.13	33045	5112.88	5112.90	0.02
03523	5144.19	5141.45	-2.74	33046	5118.65	5116.93	-1.72
03526	5126.58	5124.78	-1.80	33047	5122.58	5120.56	-2.02
04010	5129.17	5127.42	-1.75	33059	5099.54	5103.98	4.44
04013	5125.10	5123.17	-1.93	33060	5106.29	5107.70	1.41
04017	5125.46	5124.11	-1.35	33064	5111.19	5111.27	0.08
04019	5126.59	5124.61	-1.98	33500	5106.59	5107.69	1.10
04021	5124.03	5122.34	-1.69	33501	5115.92	5116.52	0.60
04024	5123.75	5121.67	-2.08	33502	5113.73	5111.38	-2.35
04026	5128.70	5127.10	-1.60	33505	5104.76	5103.35	-1.41
04030	5136.72	5134.22	-2.50	33506	5104.45	5102.71	-1.74
04524	5142.02	5139.21	-2.81	33507	5103.54	5102.02	-1.52
04525	5138.90	5139.74	0.84	33509	5105.23	5103.13	-2.10
04527	5125.83	5124.19	-1.64	33510	5107.85	5106.94	-0.91
04528	5124.66	5123.06	-1.60	33511	5109.07	5107.11	-1.96
04529	5124.18	5122.42	-1.76	33512	5108.85	5107.56	-1.29
04532	5126.36	5125.18	-1.18	33514	5121.83	5120.24	-1.59
28018	5104.67	5100.97	-3.70	33531	5112.42	5110.24	-2.18
28020	5104.75	5101.19	-3.56	33533	5104.12	5102.06	-2.06
28021	5104.11	5100.70	-3.41	33534	5105.93	5102.38	-3.55
28022	5106.28	5108.62	2.34	33576	5108.10	5110.93	2.83
28027	5101.69	5100.60	-1.09	33577	5106.07	5105.32	-0.75
28503	5105.89	5106.79	0.90	33579	5102.88	5102.90	0.02
28513	5104.77	5104.05	-0.72	33580	5104.27	5102.78	-1.49
33001	5115.86	5115.26	-0.60	33582	5102.54	5103.02	0.48
33014	5100.87	5103.92	3.05	34002	5124.37	5121.92	-2.45
33018	5098.82	5103.47	4.65	34008	5111.79	5110.72	-1.07
33025	5102.05	5100.86	-1.19	34515	5122.87	5120.53	-2.34

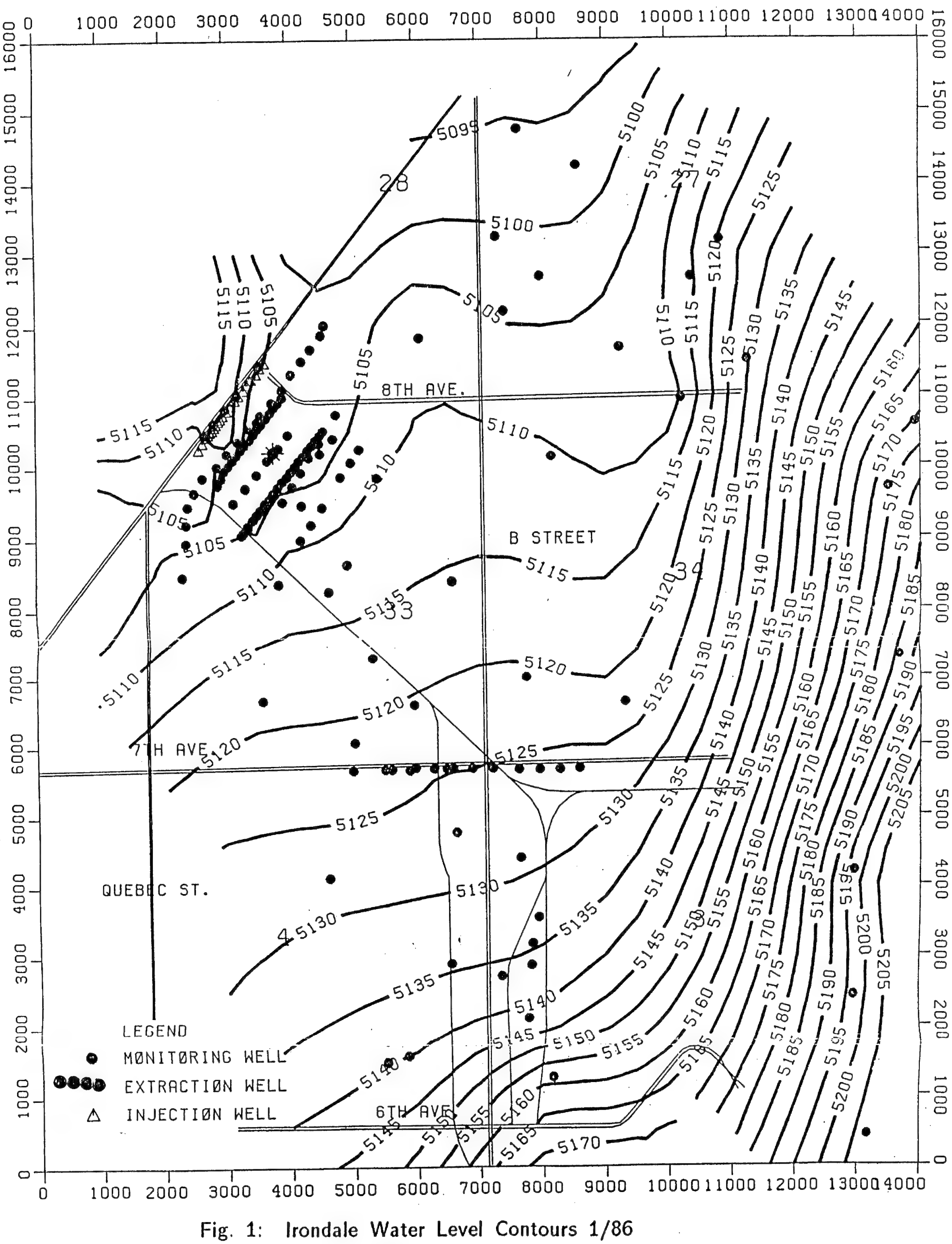


Fig. 1: Irondale Water Level Contours 1/86
(feet above MSL)

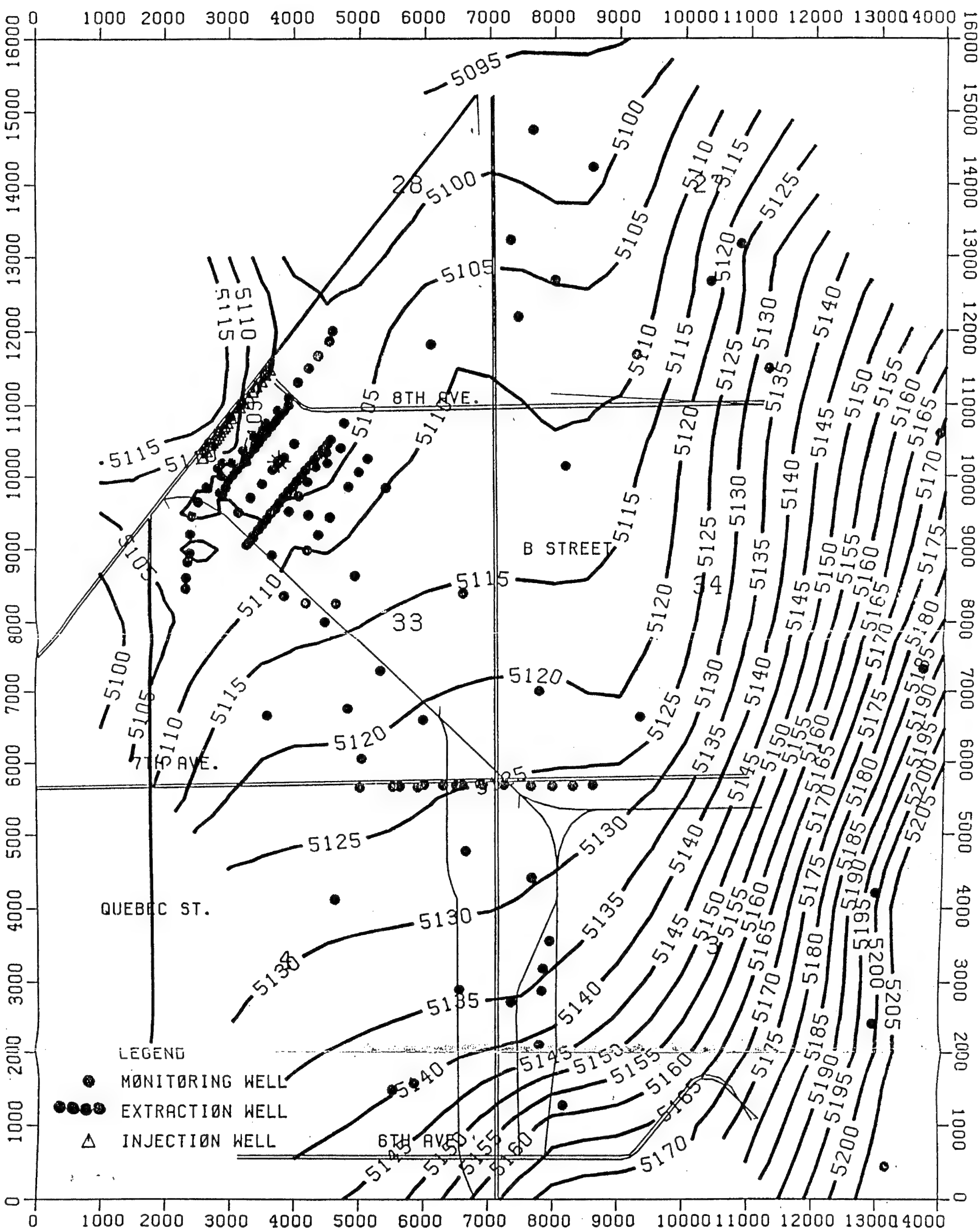


Fig. 2: Irondale Water Level Contours 4/86
(feet above MSL)

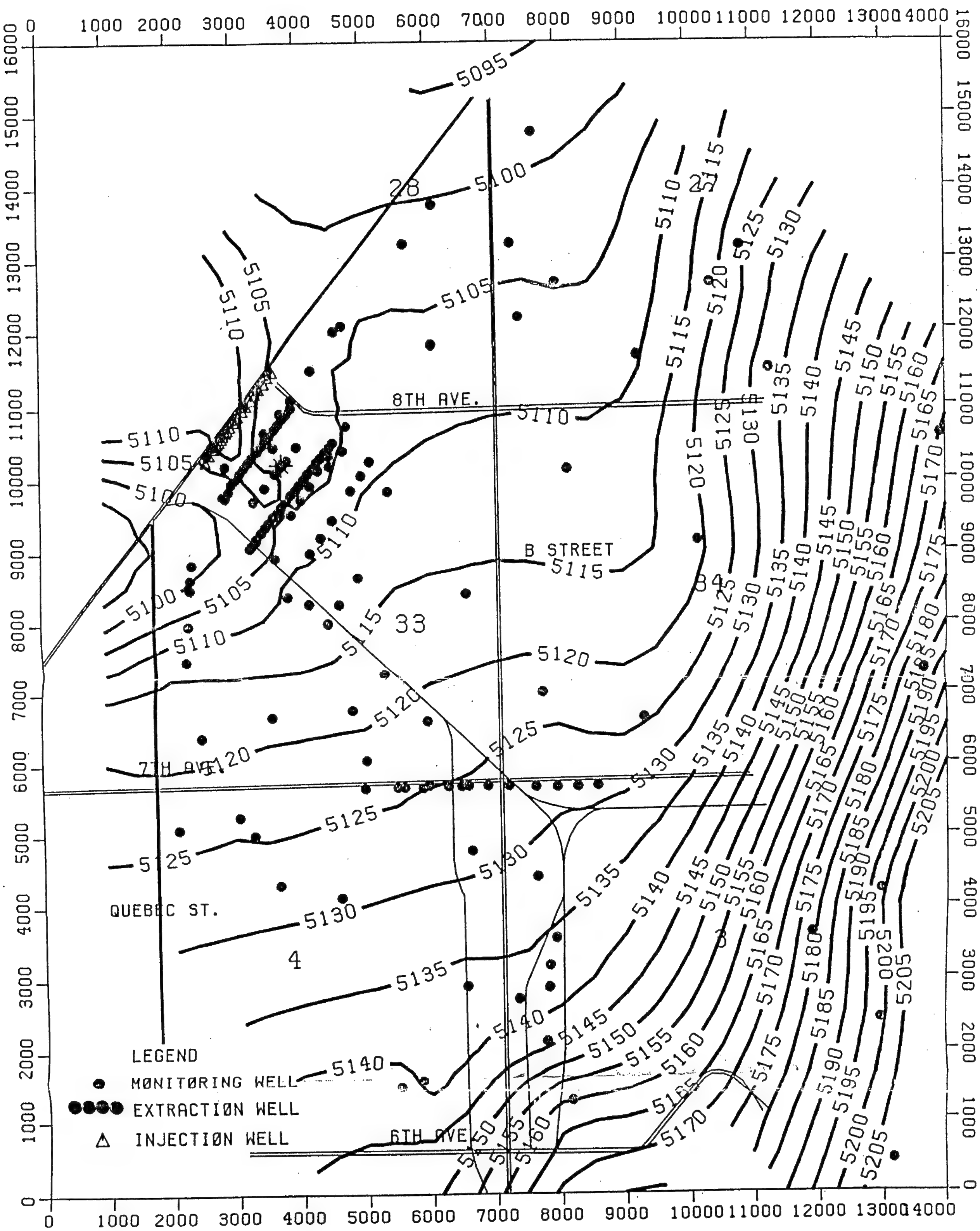


Fig. 3: Irondale Water Level Contours 7/86
(feet above MSL)

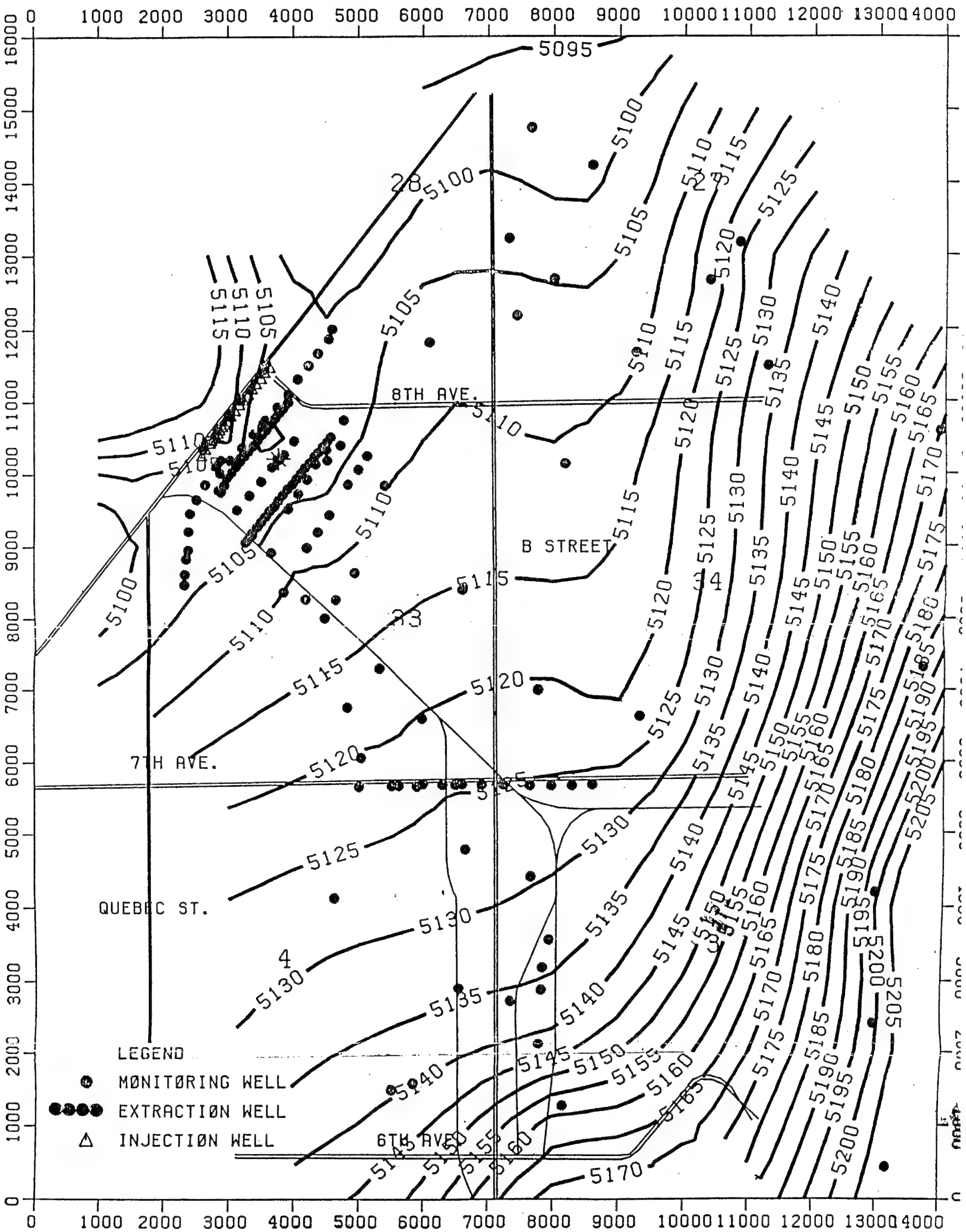


Fig. 4: Irondale Water Level Contours 10/86
(feet above MSL)

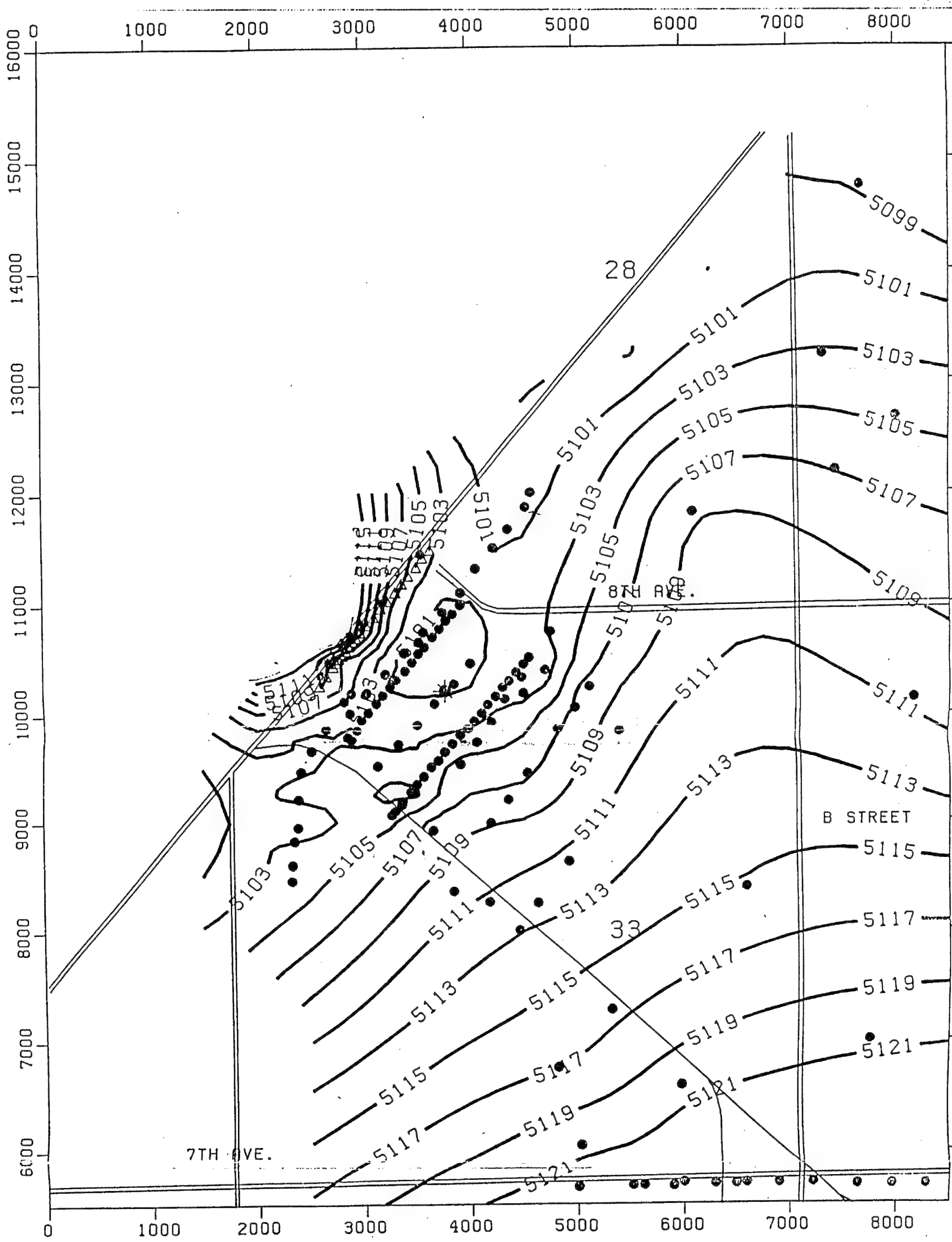
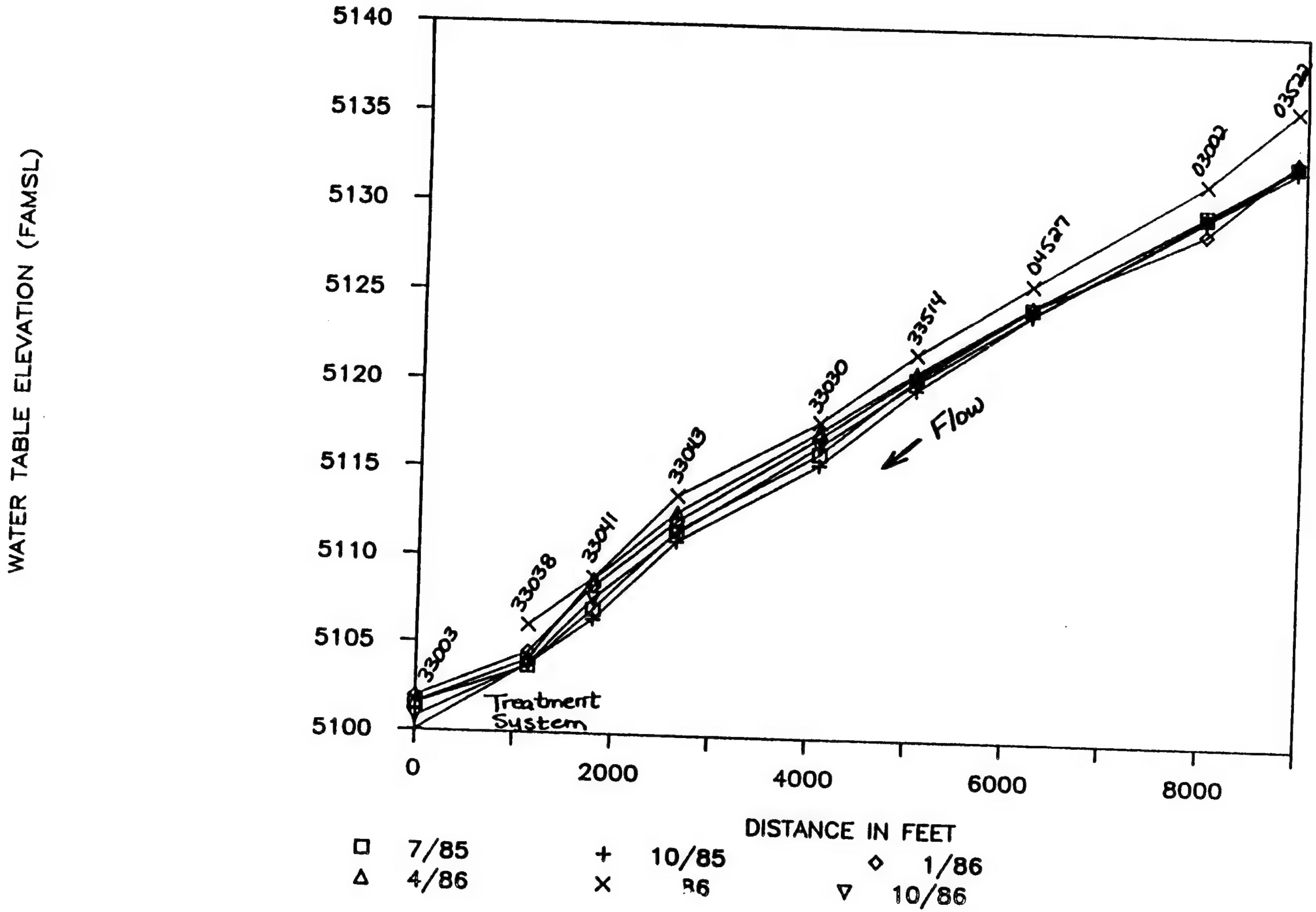


Fig. 5: Blown–Up Water Level Contours 10/86
around the Treatement System
(feet above MSL)

FIG 6 IRONDALE TRANSECT HYDROGRAPH



APPENDIX B
CHEMICAL DATA

		Page
Table 1	- Influent and Effluent DBCP Concentrations	B-1
Table 5	- Irondale DBCP Control System 1986 Sampling Schedule and Analytical Data	B-2
Table 6	- DBCP Concentration Data	B-5
Figure 7	- Irondale DBCP Sampling Wells - 1986	B-7
Figure 8	- Irondale DBCP Concentration Contours 1/86	B-8
Figure 9	- Irondale DBCP Control System Bedrock Surface	B-9
Figure 10	- Irondale DBCP Concentration Contours 4/86	B-10
Figure 11	- Irondale DBCP Concentration Contours 7/86	B-11
Figure 12	- Irondale DBCP Concentration Contours 10/86	B-12

TABLE 1

INFLUENT AND EFFLUENT DBCP CONCENTRATIONS

Sample Date	DBCP, PPB Adsorber V-101 Influent	Adsorber V-101 Effluent	Adsorber V-102 Influent	Adsorber V-102 Effluent
01/13/86	0.31	BDL	0.29	BDL
01/27/86	0.32	BDL	0.29	BDL
02/10/86	0.39	BDL	0.28	BDL
02/24/86	P	BDL	P	BDL
03/10/86	0.23	BDL	0.26	BDL
03/25/86	0.40	BDL	0.39	BDL
04/14/86	0.39	BDL	0.33	BDL
04/28/86	0.35	BDL	0.30	BDL
05/12/86	0.29	BDL	0.26	BDL
05/27/86	0.33	BDL	0.32	BDL
06/09/86	0.36	BDL	0.30	BDL
06/23/86	0.35	BDL	0.28	BDL
07/14/86	0.35	BDL	0.27	BDL
07/28/86	0.32	BDL	0.33	BDL
08/11/86	0.42	BDL	0.32	BDL
08/25/86	0.37	BDL	0.35	BDL
09/08/86	0.41	BDL	0.40	BDL
09/22/86	0.42	BDL	0.40	BDL
10/07/86	0.47	BDL	0.39	BDL
10/27/86	P	BDL	0.23	BDL
11/10/86	0.40	BDL	0.36	BDL
11/24/86	0.34	BDL	0.28	BDL
12/08/86	P	BDL	P	BDL
12/22/86	0.38	BDL	0.34	BDL

NOTE: BDL = Below detection limit of 0.06 ppb
P = Indicates presence of DBCP between 0.06 ppb limit of detectability and 0.20 ppb limit of determinability

TABLE 5

IRONDALE DBCP CONTROL SYSTEM 1986 SAMPLING SCHEDULE AND ANALYTICAL DATA

I. ADSORBERS V-101 and V-102 (Sample 2nd and 4th Monday for Total of 12 Samples Monthly)

	INFLUENT DBCP, PPB	
	V-101	V-102
RANGE	P-0.47	P-0.40
AVERAGE	0.33	0.31

NOTE: The effluent analyses were BDL for the entire period

II. EXTRACTION WELLS (Total of 17 Samples Quarterly)

WELL I.D.	DBCP, PPB RANGE	AVERAGE
W-2	P-0.28	P
W-4	BDL	BDL
W-8	BDL-P	BDL
W-10	BDL	BDL
W-12	BDL-0.38	P
W-14	BDL	BDL
W-33	BDL-P	BDL
W-35	BDL	BDL
W-16	1.19-1.72	1.35
W-18	0.33-0.73	0.49
W-20	P-0.21	P
W-25	1.39-3.17	2.29
W-27	1.11-1.55	1.25
W-29	0.47-3.07	1.78
W-31	P-3.29	1.19
W-36	BDL-0.58	0.29
W-38	BDL-P	BDL

III. ONPOST MONITORING WELLS (Total of 36 Samples Quarterly)

WELL I.D.	DBCP, PPB RANGE	DBCP, PPB AVERAGE
S-0	BDL	BDL
S-1	BDL	BDL
S-2	BDL	BDL
S-3	BDL	BDL
S-6	P	P
S-7	BDL	BDL
S-10	BDL	BDL
S-13	BDL	BDL
S-14	BDL	BDL
S-23	25.1-40.4	28.6
S-26	BDL	BDL
S-27	BDL	BDL
S-28	P-0.26	P
S-29	BDL	BDL
S-33	BDL-P	BDL
3-9	1.01-2.33	1.68
Army 13	2.08-3.54	2.75
Army 15	3.19-4.20	3.63
Army 26	21.5-34.4	29.6
Army 28	0.25-0.55	0.42
28-21	BDL	BDL
33-30	1.05-4.64	2.86
33-39	0.30-1.75	0.81
33-40	0.39-1.14	0.71
33-41	0.60-0.87	0.71
33-42	1.61-2.82	2.31
33-43	0.34-0.90	0.56
33-44	1.17-3.08	1.89
33-62	1.39-2.23	1.81
33-70	BDL-1.97	0.71
33-71	BDL-P	P
33-72	BDL	BDL
33-73	BDL-P	BDL
33-580	BDL-1.47	0.42
33-581	BDL-0.37	P
33-582	BDL-0.20	P

IV. ONPOST MONITORING WELLS (Total of 11 Samples Semi-Annually)

WELL I.D.	DBCP, PPB RANGE	AVERAGE
33-18[b)]	BDL	BDL
33-45	BDL	BDL
33-46	BDL	BDL
33-59	BDL	BDL
33-60	BDL	BDL
33-64	BDL	BDL
33-576	BDL	BDL
33-577	BDL	BDL
33-578	BDL	BDL
33-583	BDL	BDL

b) If 33-18 is dry, sample 33-19 and 33-20

V. OFFPOST MONITORING WELLS (Total of 8 Samples Quarterly)

WELL I.D.	DBCP, PPB RANGE	AVERAGE
M-1	BDL	BDL
M-2	BDL	BDL
M-3	BDL	BDL
M-4	BDL	BDL
M-5	BDL	BDL
M-6	BDL	BDL
C	BDL	BDL
C III	BDL	BDL

NOTE: BDL = Below detection limit of 0.06 PPB
P = Indicates presence of DBCP between 0.06 PPB limit of detectability and 0.20 PPB limit of determinability

TABLE 6

DBCP CONCENTRATION DATA
DBCP IN PPB

Well No.	Jan 86	April 86	July 86	Oct 86
S-0	BDL (1)	BDL	BDL	BDL
S-1	BDL	BDL	BDL	BDL
S-2	BDL	BDL	BDL	BDL
S-3	BDL	BDL	BDL	BDL
S-6	P (2)	P	P	P
S-7	BDL	BDL	BDL	BDL
S-10	BDL	BDL	BDL	BDL
S-13	BDL	BDL	BDL	BDL
S-14	BDL	BDL	BDL	BDL
S-23	25.5	25.1	40.4	23.6
S-26	BDL	BDL	BDL	BDL
S-27	BDL	BDL	BDL	BDL
S-28	P	P	P	0.26
S-29	BDL	BDL	BDL	BDL
S-33	P	P	BDL	BDL
3-9	1.76	1.01	1.6	2.33
Army 13	2.65	2.08	2.7	3.54
Army 15	3.73	3.09	4.2	3.38
Army 26	21.5	30.82	34.4	31.6
Army 28	0.45	0.25	0.55	0.41
28-21	BDL	BDL	BDL	BDL
33-18	-	BDL	-	BDL
33-30	3.27	1.05	2.48	4.64
33-39	0.57	0.62	0.30	1.75
33-40	1.14	0.39	-	0.51
33-41	0.66	0.60	0.71	0.87
33-42	1.61	2.82	-	2.62
33-43	0.90	0.58	0.34	0.41
33-44	1.33	1.17	3.08	1.99
33-45	-	BDL	-	BDL
33-46	-	BDL	-	BDL
33-59	-	BDL	-	BDL
33-60	-	BDL	-	BDL
33-62	1.39	2.23	-	DRY
33-64	-	BDL	-	BDL
33-70	.65	BDL	.42	1.97
33-71	BDL	P	BDL	BDL
33-72	BDL	BDL	BDL	BDL
33-73	BDL	P	BDL	BDL

TABLE 6

DBCP CONCENTRATION DATA
DBCP IN PPB

Well No.	Jan 86	April 86	July 86	Oct 86
33-576	-	BDL	-	BDL
33-577	-	BDL	-	BDL
33-578	-	BDL	-	BDL
33-579	-	BDL	-	BDL
33-580	0.24	BDL	BDL	1.47
33-581	P	BDL	BDL	0.37
33-582	BDL	BDL	0.20	P
33-583	BDL	BDL	-	BDL
EXTRACTION WELLS				
W-2	P	0.28	P	BDL
W-4	BDL	BDL	BDL	BDL
W-8	BDL	BDL	BDL	P
W-10	BDL	BDL	BDL	BDL
W-12	P	BDL	BDL	0.38
W-14	BDL	BDL	BDL	BDL
W-33	BDL	BDL	BDL	P
W-34	-	BDL	-	-
W-35	BDL	BDL	BDL	BDL
W-16	1.29	1.72	1.19	1.19
W-18	0.73	0.45	0.33	0.46
W-20	0.21	P	P	P
W-25	2.12	1.39	2.49	3.17
W-27	1.11	1.14	1.19	1.55
W-29	1.80	0.47	1.78	3.07
W-31	0.58	P	0.80	3.29
W-36	BDL	BDL	0.58	0.56
W-37	-	BDL	-	-
W-38	BDL	BDL	P	BDL
OFF RMA				
M-1	BDL	BDL	BDL	BDL
M-2	-	BDL	BDL	BDL
M-3	-	BDL	BDL	BDL
M-4	BDL	BDL	BDL	BDL
M-5	-	BDL	BDL	BDL
M-6	BDL	BDL	BDL	BDL
C	-	BDL	BDL	BDL
C-III	BDL	BDL	BDL	BDL

(1) BDL = below detectable limit of .06 ppb
(2) P = less than .20 ppb but above detectable limit

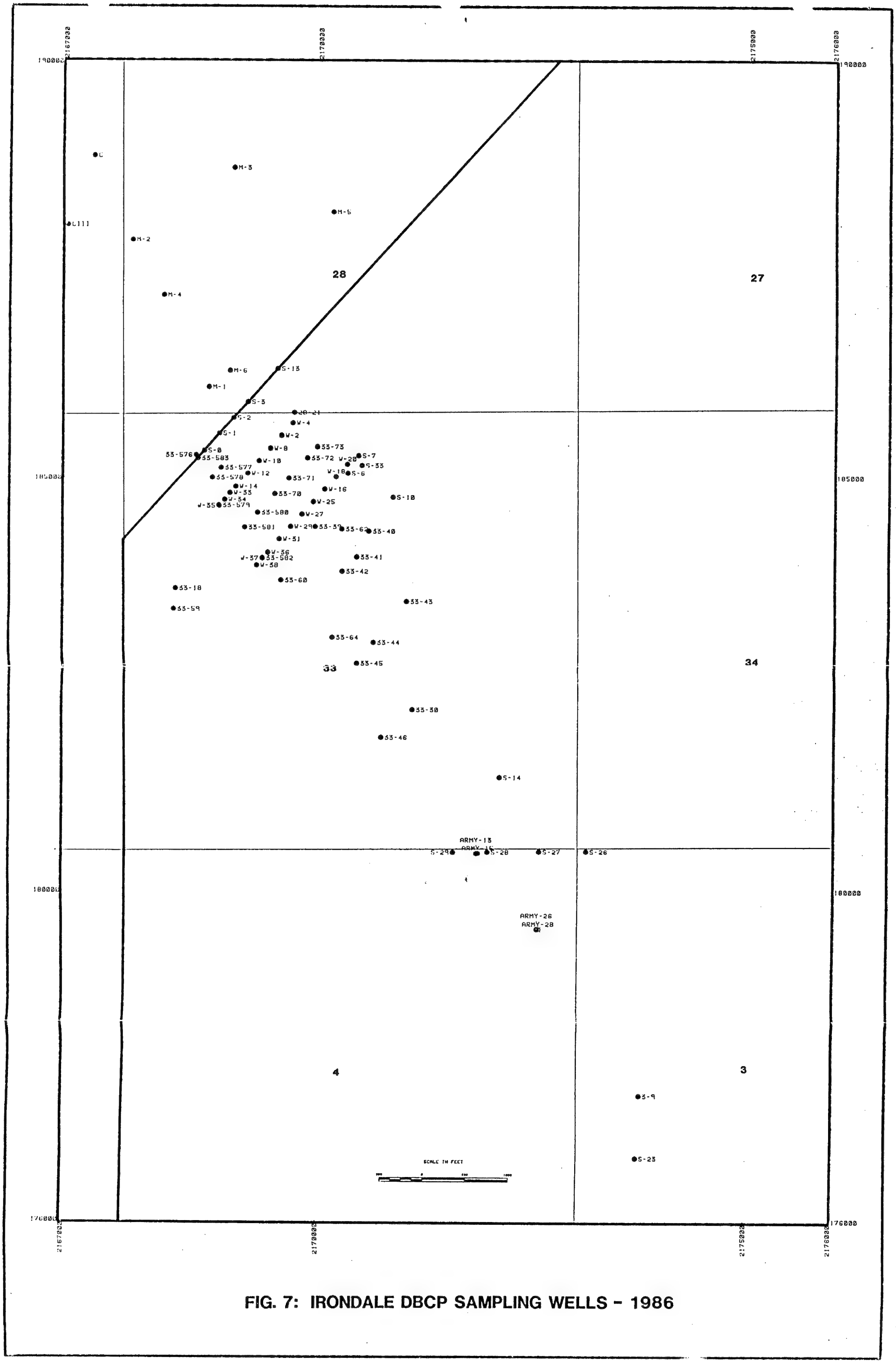


FIG. 7: IRONDALE DBCP SAMPLING WELLS - 1986

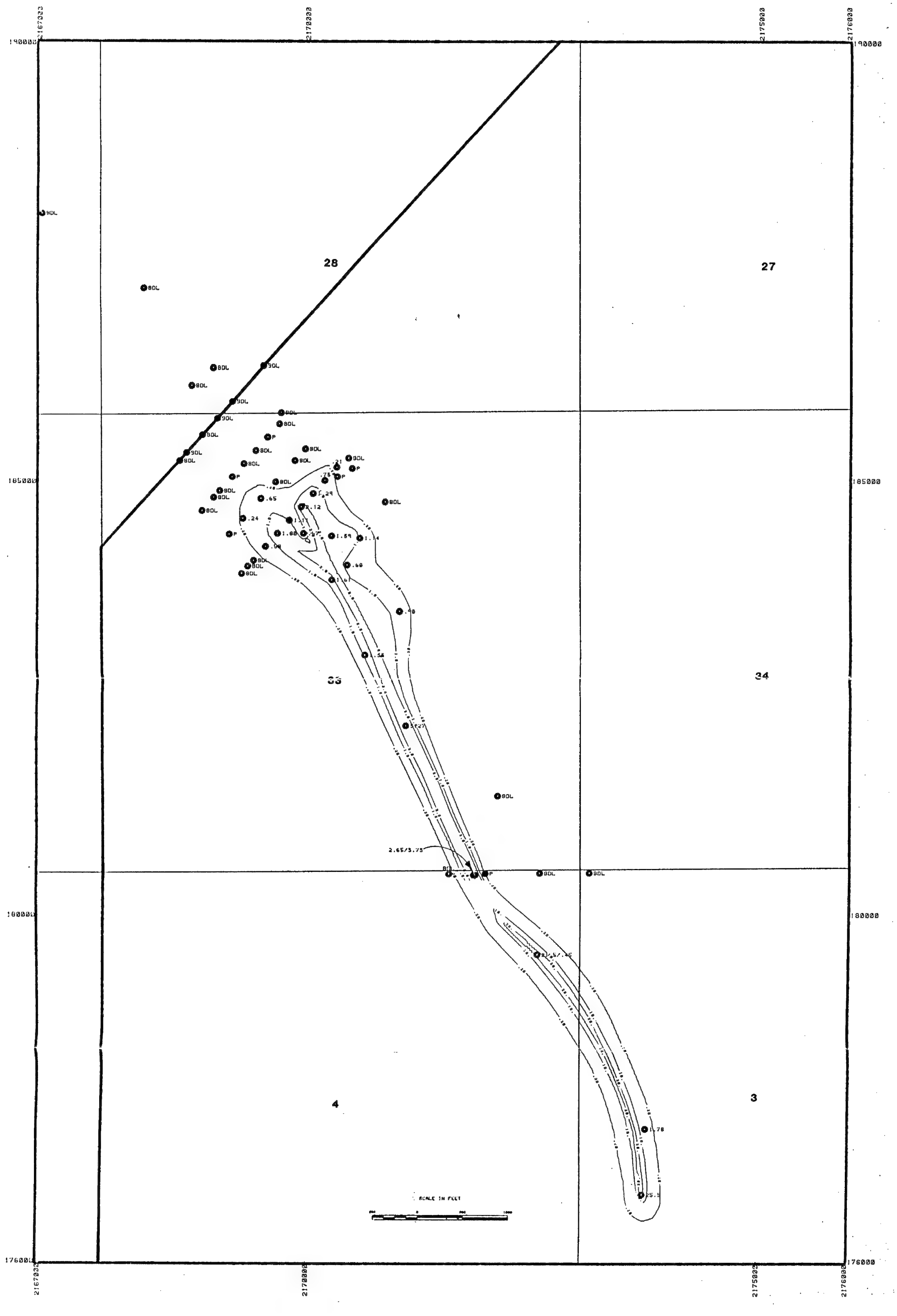


FIG. 8: IRONDALE DBCP CONCENTRATION CONTOURS 1/86
(VALUES ARE IN PPB)

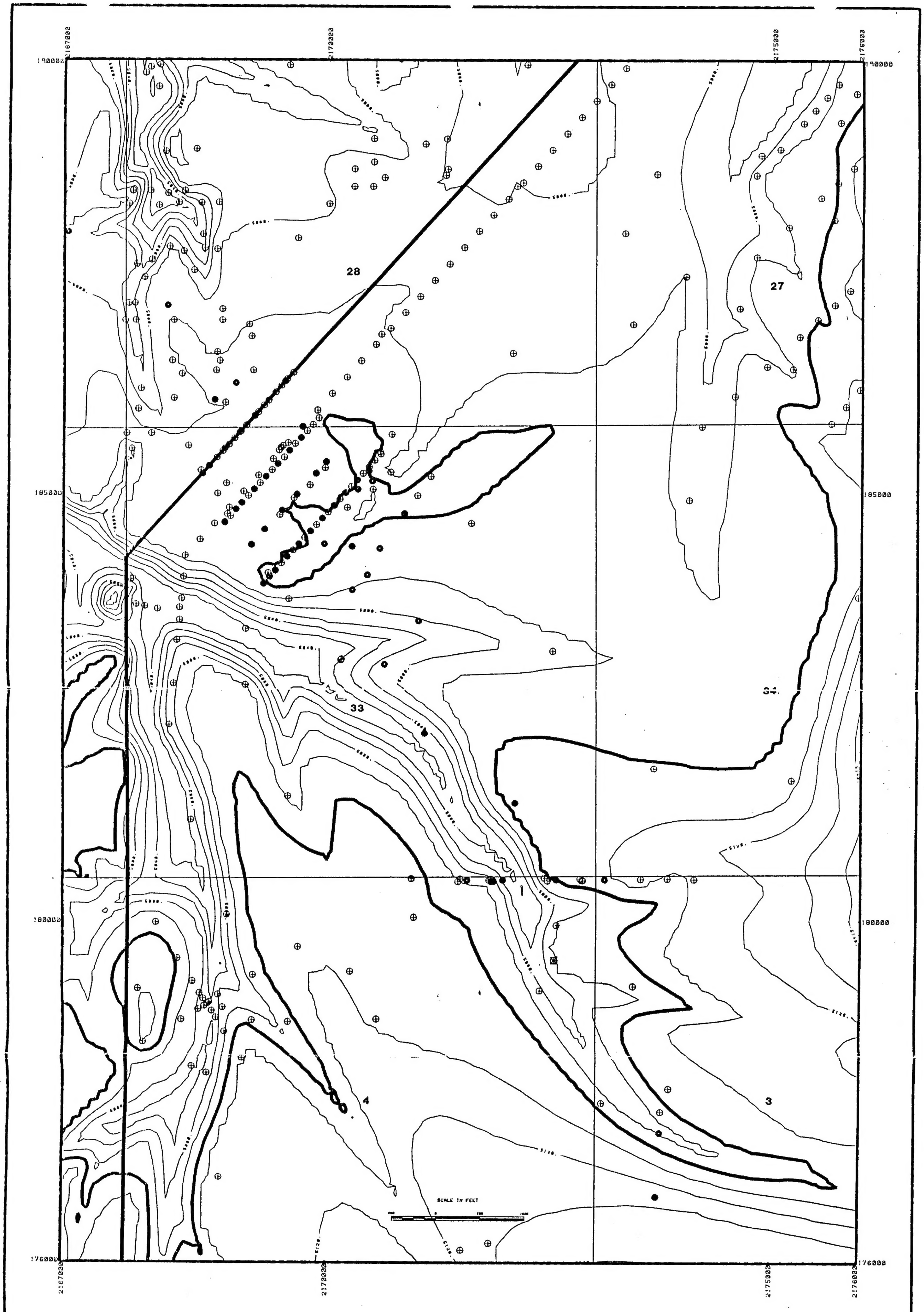


FIG. 9: IRONDALE DBCP CONTROL SYSTEM BEDROCK SURFACE

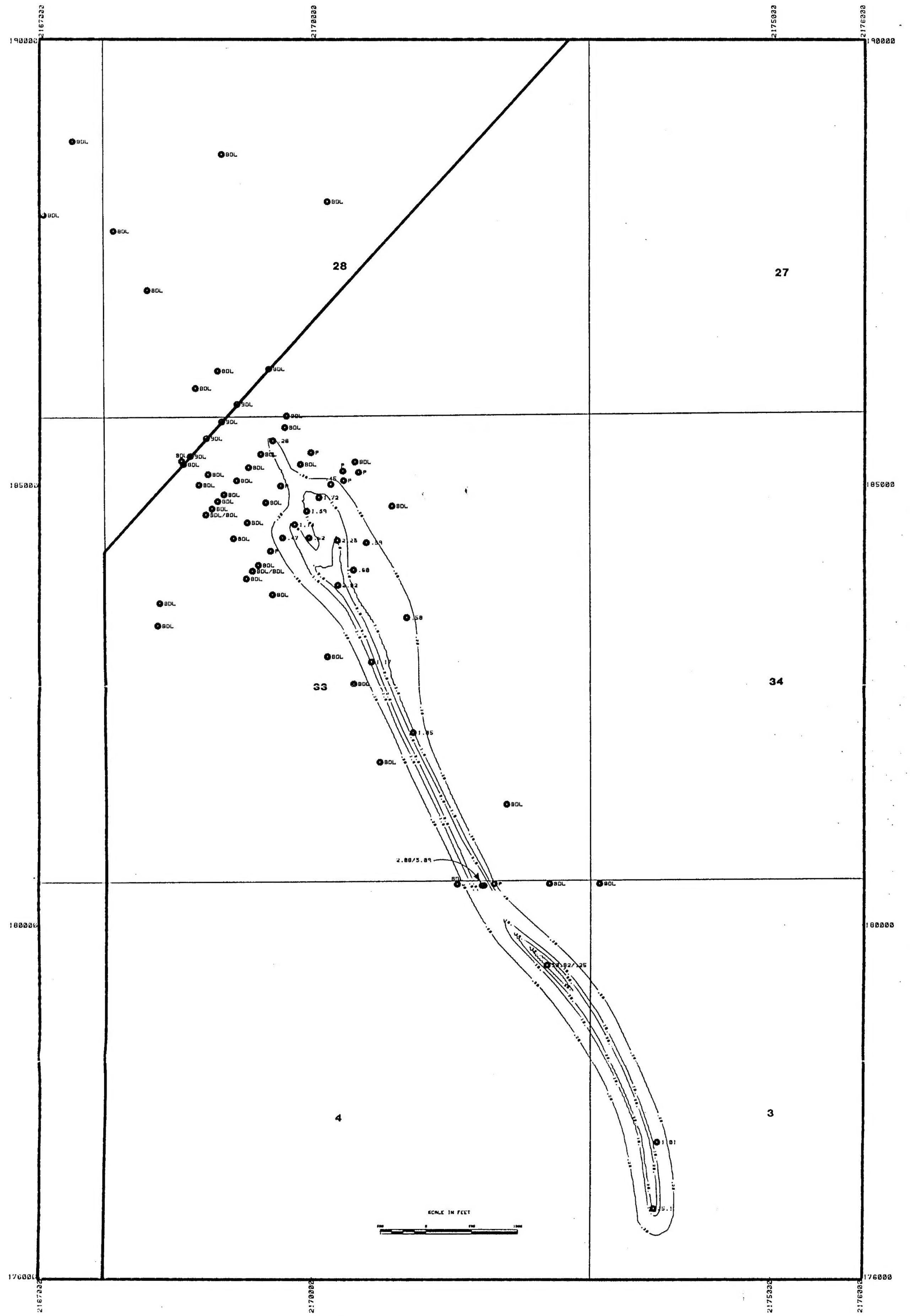


FIG. 10: IRONDALE DBCP CONCENTRATION CONTOURS 4/86
(VALUES ARE IN PPB)

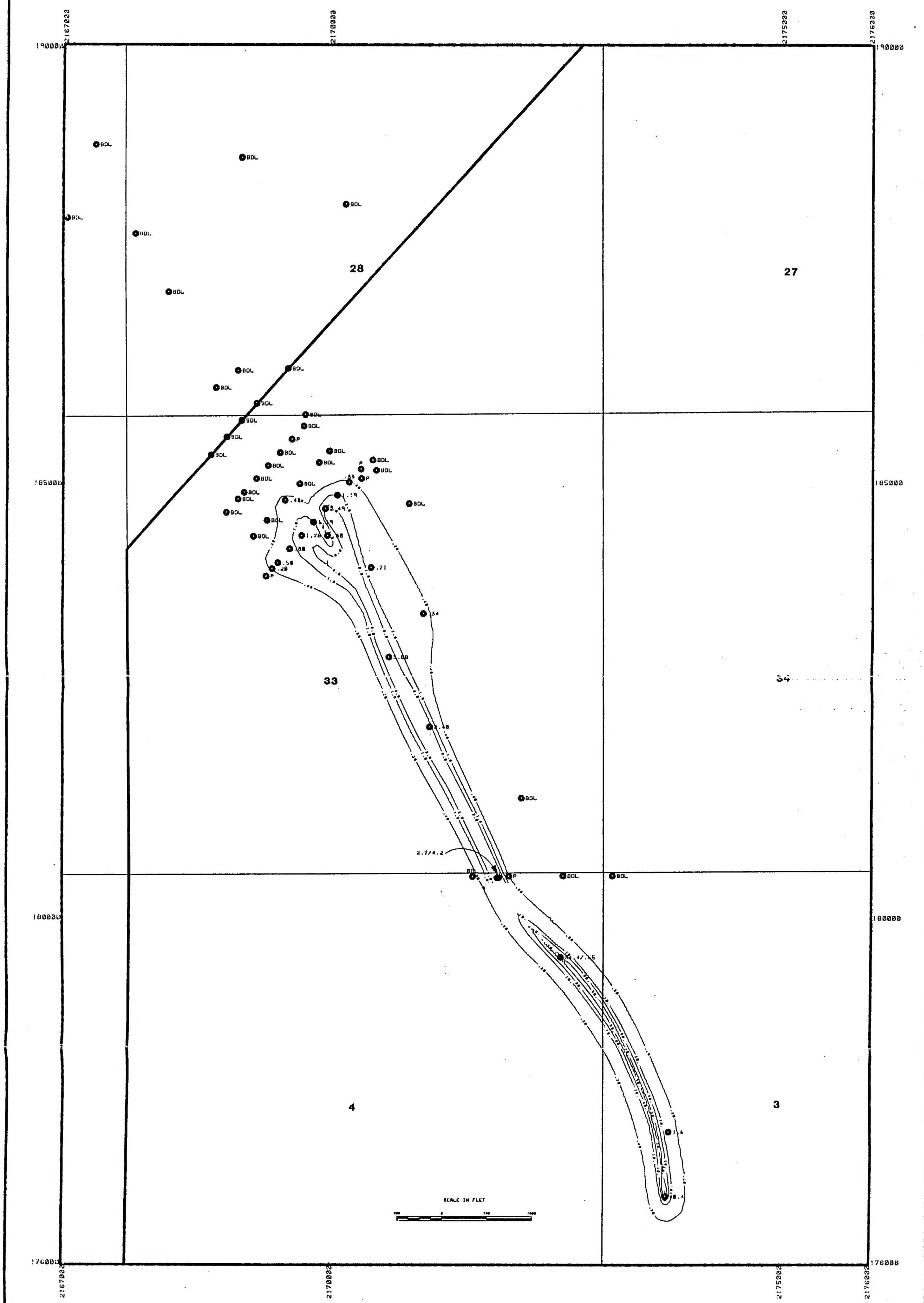


FIG. 11: IRONDALE DBCP CONCENTRATION CONTOURS 7/86
(VALUES ARE IN PPB)

B-11

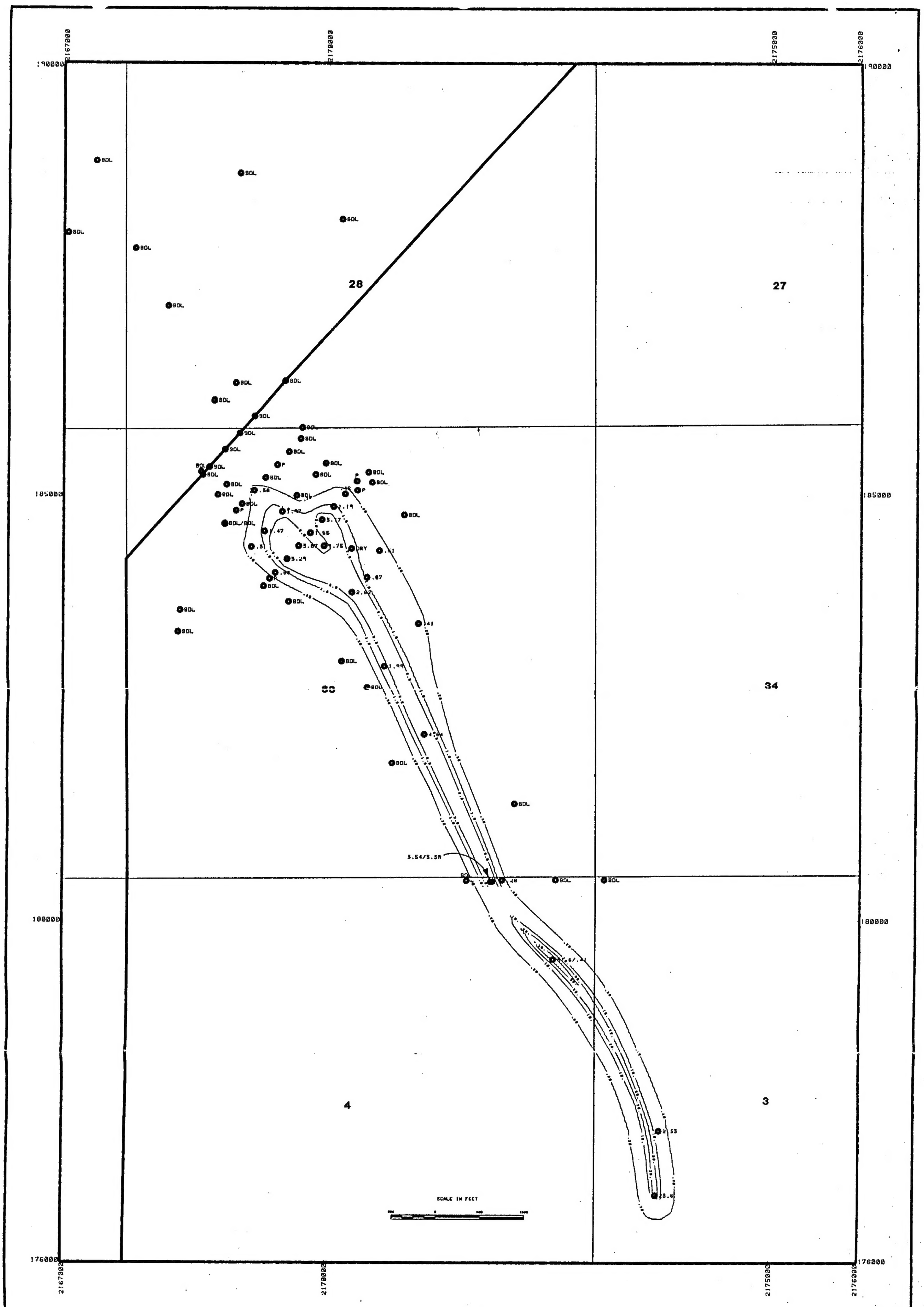


FIG. 12: IRONDALE DBCP CONCENTRATION CONTOURS 10/86 (VALUES ARE IN PPB)